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November 2, 1933

Engineering News-Record

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Experimental Cement Plant at University of California

Cincinnati's New Union Railroad Terminal

Sewage Plant Effluent To Be Used for Boiler Water

Stabilizing Gravel Roads With Calcium Chloride

Concrete Rigid-Frame Bridges for Railroad Loadings

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Experimental Cement Plant at University of California

Dual-kiln unit constructed at engineering materials laboratory to study results of variations in burning, including subsequent heat treatment of clinker—Continuous grinding mill with temperature control permits comparisons of grinding energy

By J. W. Kelly
Research Engineer, Engineering Materials Laboratory, University of California

RESEARCH on a comprehensive scale into problems of manufacturing cement and other materials requiring calcination or heat treatment has been made possible at the engineering materials laboratory of the University of California with the installation of a complete dual-kiln unit and a three-stage continuous grinding mill. Combined with the laboratory facilities developed during the elaborate study of the properties of cements for Boulder Dam, the new equipment provides for the study of cement problems from the raw materials to the final product, particularly with regard to the effects of heat treatment of clinker in controlled atmospheres, a field of recent interest. Problems in the manufacture of lightweight aggregates are also under investigation, and a study of limes is contemplated.

The rotary kilns of the experimental plant are located within the open court of the U-shaped laboratory building (*ENR*, Sept. 8, 1932, p. 284). The kilns are 30 in. in outside diameter, 30 ft. long, and have a normal capacity of 60 to 150 lb. of clinker per hour. They are operated under automatic control and are equipped throughout with facilities for observing operating conditions.

The primary kiln used for burning the clinker is fundamentally similar to a commercial cement kiln. Clinker from this primary unit may be discharged into stationary coolers for rapid or retarded cooling, or may be passed directly by gravity into the secondary kiln, where it may either be cooled gradually at a controlled rate or may be heat-treated. The secondary kiln is the first to be built especially to permit cooling or heat treatment under oxidizing or reducing conditions, which conditions have been found to influence the formation of the various clinker compounds. The kilns are lined with high-alumina brick, 4½ in. thick.

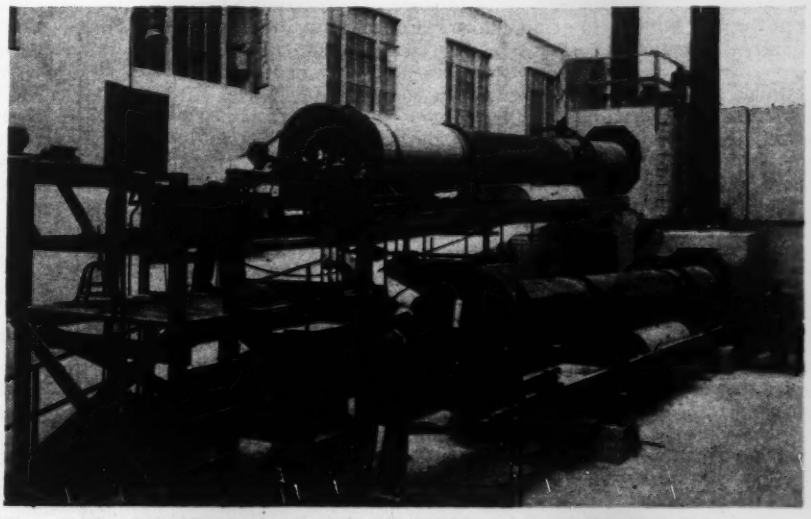


Fig. 1—In this general view of the new dual-kiln cement-manufacturing unit at the University of California the operator is measuring the temperature in the primary kiln with an optical pyrometer mounted on a graduated quadrant. Orsat apparatus for flue-gas analysis is on the table at the far end of the secondary kiln.

Each kiln is mounted on a welded structural-steel frame, pivoted at one end, and can be raised or lowered at the other end by means of screw jacks to change its inclination from horizontal to 1 on 12. Depending upon inclination and speed of rotation, the time of passage of the clinker may be varied from a few minutes to 2 or 3 hours. A speed range of 0.6 to 12 r.p.m. is provided through a direct-drive unit comprising

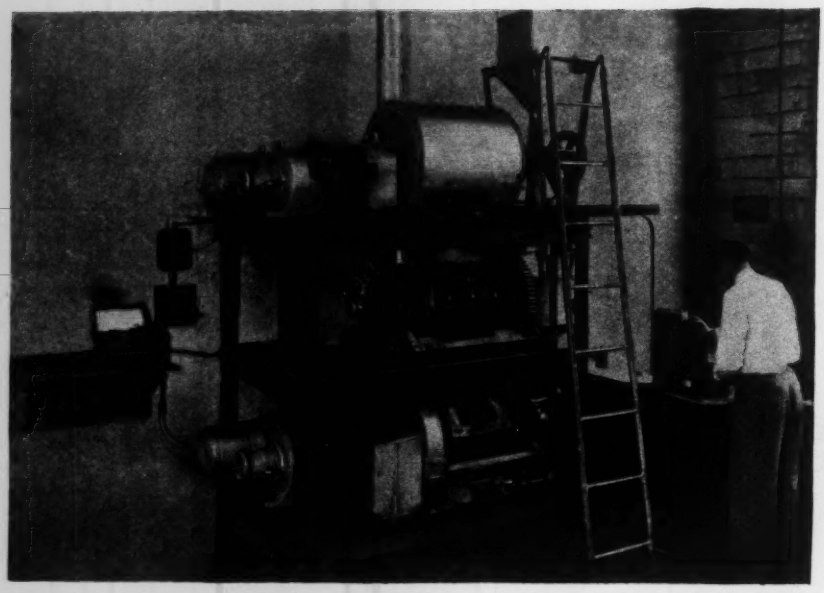


Fig. 2—Three-stage continuous grinding mill: primary unit (above) with insulating hood installed; secondary unit with half of hood removed; finish unit with door removed; suspension turbidimeter at right.

a two-speed 3-hp. motor operating through a variable-speed drive (range 10 to 1), which engages a ring gear on the kiln.

The kilns are fired with either oil or gas, with directional control of the flame. Temperatures, which may range up to 3,000 deg. F., are measured by means of an optical pyrometer that is mounted on a graduated quadrant and permits temperatures to be observed at any point along the kiln. To measure accurately the temperature of the clinker (eliminating the effect of the flame), provision is made for momentarily cutting off the fuel supply and preventing the escape of gases from the kiln while observation is made with the optical pyrometer.

The kiln draft is controlled to any desired degree by an automatic furnace-pressure controller, which operates a butterfly damper in the stack; this apparatus will compensate for sudden changes in operating conditions within a few seconds. The draft may also be altered manually when desired by means of auxiliary pushbutton control. Its amount is measured by an inclined draft gage.

Provision is made for flue-gas analysis by means of the Orsat apparatus. In addition, a chromel-alumel thermocouple is installed at the discharge end of each kiln, and a companion thermocouple is installed in the stack at a point 15 ft. above the base. The relative difference in temperature between these two points at a given time indicates whether the atmosphere is oxidizing or reducing. By observation of thermocouple temperatures the percentage of combustible gases may be quickly determined without the use of the Orsat apparatus. By means of chromel-alumel thermocouples, temperature measurements are made of all discharged clinker, thus determining the cooling gradient after discharge is completed.

Raw materials are ordinarily fed in the form of slurry, continuously agitated by compressed air.

Grinding mills

The experimental grinding equipment consists of a three-stage continuous mill with a discharge capacity of 30 lb. of normal portland cement per hour and a 30-in. by 3-ft. closed batch mill for which the usual charge of material is 125 lb. The mills were designed and built at the laboratory. They are employed both to reduce raw materials and to grind clinker. Comparative grinding costs can be determined, based on power consumption measured by means of watt-hour meters connected to the electric driving motors.

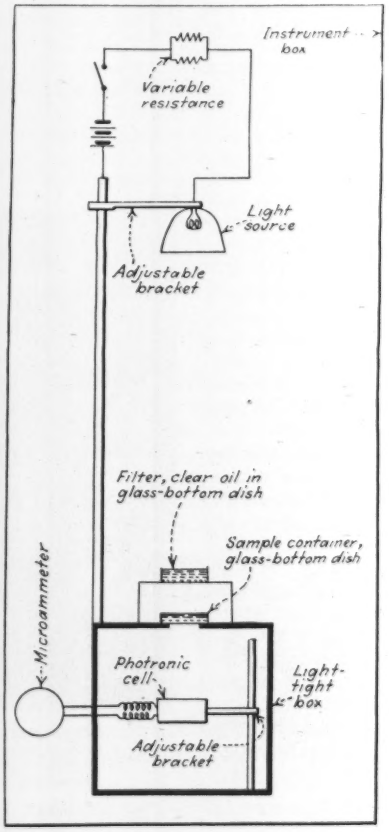
The units of the continuous mill are mounted one above another (Fig. 2), each resting on two pairs of rollers, which run in flanged tracks encircling the ends of the shell. A tight-fitting door, extending flush with the inside of the shell, provides for changing the ball charge to suit grinding conditions. In the discharge head are $\frac{1}{8}$x2-in. slots through which the ground material is released. Lifting vanes attached to the outside of this head then pick up the material and drop it into a discharge tube.

To control the temperature of grinding, each unit is equipped with a removable insulating hood and gas heater. Temperatures up to 400 deg. F. may be attained, and the temperature of each individual unit is maintained within 10 deg. of the desired heat, which ordinarily corresponds to that obtaining in a commercial mill. Cooling may be accomplished by forcing air through the same system of hoods. Temperatures are measured by means of a copper-constantan thermocouple on the delivery side of the slotted discharge head of each unit.

The primary unit of the continuous mill is 15½ in. in diameter and 15½ in. long. It is driven by a ¾-hp. electric motor with a self-contained variable-speed drive which engages a ring gear on the shell. The speed range is 22 to 66 r.p.m. The secondary and finish units are 13½ in. in diameter and 19½ in. long. They are driven by one 1½-hp. electric motor with a self-contained variable-speed drive that engages a ring gear on the shell of the finish unit and drives the secondary unit by means of a roller chain operating on a sprocket on the unit shaft. The speed range is 22 to 66 r.p.m.

The clinker or other material is preground in the batch mill or crushed to pass the No. 8 sieve, and then placed in the feed hopper of the primary unit. From the feed hopper the material passes on to a variable-speed rotating feed table from which it is removed at a controlled rate by an adjustable scraper. The material is then conveyed into the primary unit by means of a helical screw mounted on the shaft of

Fig. 3—Diagram of suspension turbidimeter used for determinations of fineness or specific surface.



the unit. Material discharged from either the primary or the secondary unit passes into a hopper from which a similar helical screw feeds it into the next unit. Samples may be taken from the hoppers through portholes. As ordinarily operated, the three units increase the fineness (specific surface) by approximately equal amounts.

Control of grinding

The fineness of ground cement is determined accurately by means of a new type of apparatus, called the suspension turbidimeter, which was developed in this laboratory. Rather than by the percentage passing a given sieve, fineness is expressed in terms of the *specific surface,* or surface area of particles in square centimeters per gram. The finer the cement, the greater the specific surface.

It has been determined that the reduction in intensity of a light beam as it passes through a suspension of particles is dependent upon the surface area of the particles; hence, the method employed is to measure, for a given concentration of the cement in a suitable suspending medium, the intensity of transmitted light from a fixed source as compared with the intensity of light transmitted through the clear medium alone.

The apparatus (Fig. 3) consists of a light source producing a beam of parallel rays, a heat filter, a sample container, and a light-tight box containing a photronic cell that is connected to the terminals of a microammeter. Clear castor oil is used as the suspending medium. The use of the apparatus is independent of room temperature or of temperature and viscosity of suspending medium, and in principle does not depend upon the use of Stokes' law, which involves the gravitational velocity of particles.

Results can be closely reproduced by men of average technical caliber. Determinations of fineness are made quickly and at low cost. The method has been used in the control of grinding the final compositions of cement in the Boulder Dam cement investigations, and is in use by several producers of portland cement. When a determination of particle-size distribution is desired, use is made of a "sedimentation turbidimeter" of the type that is employed in the determination of fineness of cements for Boulder Dam.

Organization

The research is under the general direction of Raymond E. Davis, director of the engineering materials laboratory. R. W. Carlson is assistant director in charge of research, and G. E. Troxell is assistant director in charge of organization. C. M. Price is chemical engineer in charge of cement production, and A. Klein is research engineer in charge of clinker-grinding studies and fineness determinations.

Sewage-Plant Effluent for Boiler Water

New activated-sludge plant for Herington, Kan., will be self-liquidating and largely self-sustaining by virtue of a water contract with the Rock Island Railroad

AN EXCELLENT example of a self-liquidating sewage-disposal project, and one that is being financed by a loan from the R.F.C., is afforded by a new activated-sludge plant under construction for the city of Herington, Kan. This town of 4,600 population is a division point on the Rock Island Railroad, which is a large user of water for its locomotive and shop boilers. The plan was conceived of selling the clear and relatively soft effluent from a new sewage-treatment plant to the railroad company, which was going to considerable expense to treat the hard water of appropriately named Lime Creek. After some negotiation a contract favorable to both the city and the railroad company was executed, and on the basis of this the R.F.C. loan (on 5 per cent 20-year bonds) was granted and the construction contract let. The plant itself is of advanced modern design and will afford the city, for the first time in its history, an adequate means for disposal of its sewage.

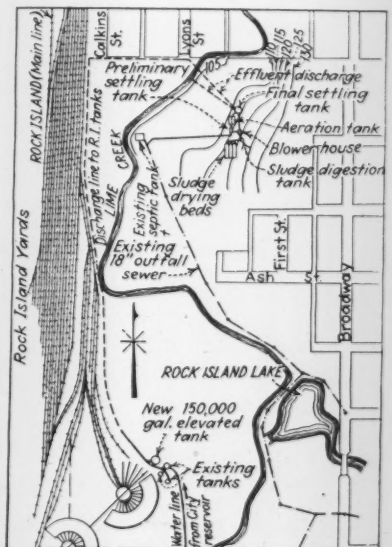


Fig. 1—Layout of new sewage-treatment and disposal works at Herington, Kan., showing effluent lines to Rock Island Railroad softening tanks. Railroad requirements for water over and above sewage effluent will be supplied from city water-supply reservoir.

The need for a sewage plant has been apparent for some years, and definite plans for it were made urgent in 1931 when the Kansas state board of health ordered that only a clear stable effluent should be discharged into Lime Creek after 1934. At the present time the city sewage is being partly treated in a heavily overloaded septic tank, and, due to lack of sufficient dilution in Lime Creek, septic conditions giving rise to odor nuisances exist. This septic condition also proved troublesome to the Rock Island, which pumps its water supply from a point in the creek only about 2,000 ft. below the septic-tank outlet. It was evident that if the city could deliver a clear water to the railroad, its softening costs would be materially reduced.

Cost estimates and contract

The accompanying tabulation gives the cost estimate for the plant and nec-

ESTIMATE OF CAPITAL OUTLAY, OPERATING EXPENSE AND REVENUE FOR NEW SEWAGE PLANT AT HERINGTON, KAN.

Capital Costs:	
Outfall sewer to plant	$ 1,060.00
Raw-sewage pumping station	8,480.00
Disposal plant	42,316,00
Cost of disposal plant	$51,856.00
Treated-sewage pumping station	$ 4,070.00
Force main to present R.I. line	2,230.00
Elevated storage tank	6,300.00
Cost of treated-sewage delivery system	$12,600.00
Total cost of system	$64,456.00
Average Annual Operating Costs:	
Disposal plant	
Fixed charges at 9 per cent	$ 4,667.00
Power for plant at 1c. per kw.-hr.	946.00
Normal operating labor	1,080.00
Extra operating labor	60.00
Maintenance and supplies	250.00
	$7,003.00
Cost of delivering water to R.I. tanks:	
Fixed charges at 9 per cent	$ 1,134.00
Power for pumping treated sewage	504.00
Power for pumping raw water	110.00
Supplies and maintenance	100.00
Total cost of delivering water	$ 1,848.00
Total cost of plant operation	$ 8,851.00
Annual revenue from the sale of 500,000 gal. per day at 5c. per 1,000 gal.	$ 9,125.00
Annual net profit	$ 274.00

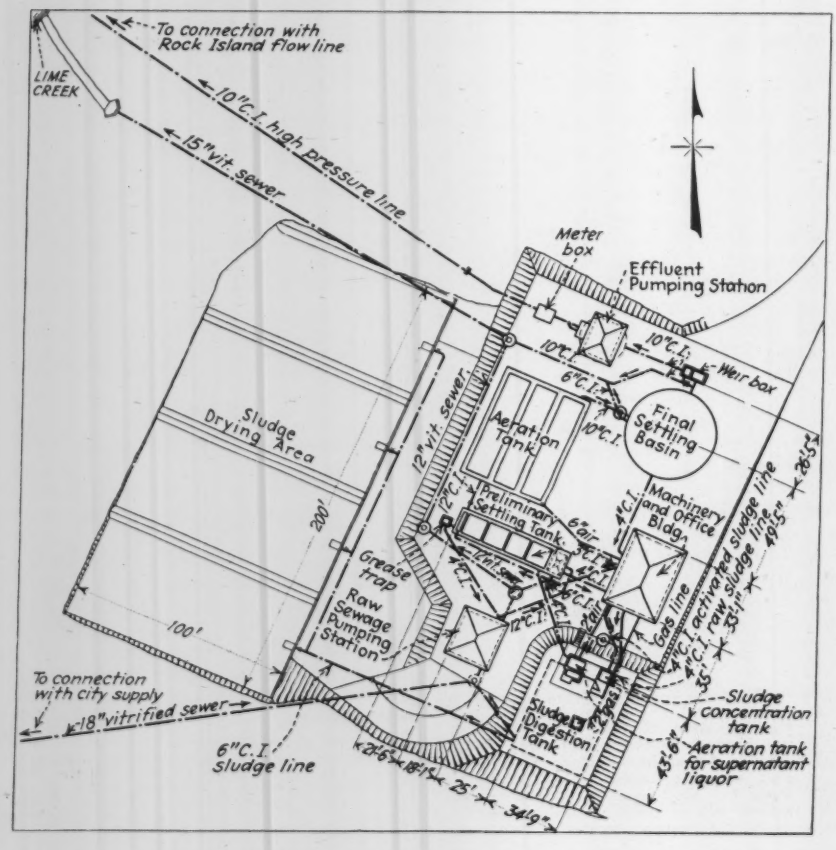
Note: The estimate does not include the cost of an 8-in. c.i. line, 4,800 ft. long, laid from the city water reservoir to the R.I. tanks for furnishing the extra water. There are other small charges such as fixed charges on the city's present pumping equipment that are not included.

essary pipe lines, as prepared by the engineers. The estimate is based on a plant to serve 6,500 persons on the assumption that the growth during the next 20 years from the present 4,500 population will be approximately equal to that which took place during the past 30 years. Sewer gagings indicate a present average daily sewage flow of about 330,000 gal., or 72 gal. per capita. Assuming 80 gal. per capita for a population of 6,500 gave a designed capacity for the new plant of 520,000 gal. per day. Pumping equipment adequate for the maximum hourly rate of dry-weather flow is contemplated; excess stormflow will enter Lime Creek through a bypass.

The estimate assumes an average daily salable effluent slightly in excess of 400,000 gal. The raw-water requirements of the Rock Island averaged about 600,000 gal. daily over the past five years and sometimes reached a maximum of nearly 1,000,000 gal. The city, therefore, had to agree to supply the total requirement, and will make up the difference by furnishing raw water from its water-supply reservoir. The estimates contemplate the sale of a total of 500,000 gal. of water daily, including raw water and sewage effluent, and the contract was drawn on this basis, using a sale price of 5c. per 1,000 gal.

Figures as to softening cost for railroad water are not available at present, but it is in the neighborhood of 7c. or 8c. per 1,000 gal. The sewage effluent will have a hardness of 6 grains per gallon, and the railroad will reduce this to 3 grains. The chemicals required will be small in amount, so that with a 5c. charge for the raw water the railroad company will save money over its former softening practice, where unusually hard and organic-laden water had to be treated.

Fig. 2—Plan of new activated-sludge plant being constructed for city of Herington, Kan.



Plant layout

As shown in Fig. 1, the new plant site is just east of the present septic tank. It is on the side of a hill above the creek and thus requires a raw-sewage pumping station and a new suction line 500 ft. long from a point near the septic tank on the existing sewer from the city. The effluent-discharge line runs in a westerly direction across Lime Creek to a connection with the existing railroad supply line from its pumping station downstream. At the end of this supply line, near the existing railroad softening tanks, a new 150,000-gal. elevated storage tank will be built. A parallel emergency discharge line also runs from the final settling basin to an outfall on the bank of Lime Creek.

The detailed layout of the disposal plant itself is shown in Fig. 2. As indicated, the plant consists of the following units:

A raw-sewage pumping station housing mechanically cleaned screens and three 350-gal.-per-minute sewage pumps.

A preliminary settling tank with mechanical equipment for sludge collection and grease removal, having a capacity providing for one-hour retention based on the designed flow of 520,000 gal. per day.

Aeration tanks using diffused air applied through porous tubes, with a capacity providing for six-hour retention, based on 125 per cent of the designed flow.

Final settling tank with mechanical equipment for sludge collection, having a capacity providing two-hour retention, based on 125 per cent of the designed flow, or 7,200 cu.ft. The designed settling rate is 675 gal. per sq.ft. per day.

A special sludge-digestion tank (of unusual design to eliminate gas-explosion dangers), equipped with heating coils and gas-collecting equipment, having a capacity of 3 cu.ft. per capita, based on a population of 6,500.

An effluent pumping station which houses two 400-g.p.m. pumps, and a sump with a capacity of 11,400 gal.

Machinery and office building which houses the office, laboratory, two 300-cu.ft.-per-minute blowers, one raw-sludge pump of 50-g.p.m. capacity, one activated-sludge pump of 60-g.p.m. capacity, and a water heater.

The sewage is primarily domestic in character, containing from 2 to 4 c.c. of settleable solids per liter, and from 110 to 180 p.p.m. of bio-chemical oxygen demand. Two small industries, a laundry and a creamery, discharge their wastes into the sanitary sewer system, but do not appreciably increase the organic load.

Several new features were incorporated in the design of the plant. Among these are details to eliminate troubles due to pumping the usual large amount of water along with the excess activated sludge into the digestion tank; to eliminate toxic action in the aeration tank when the supernatant liquor from the digestion tank is added to the raw sewage; and to prevent the entrance of air into the digestion tank when sludge is being drawn.

In order to decrease the volume of the activated-sludge to be added to the digestion tank, it will first be concentrated in a small tank with about 20-min. retention capacity. The settled sludge will be drawn off the bottom by gravity, the amount being governed by adjusting the operating head on the sludge draw-off line. The supernatant liquor from the excess activated sludge will be taken off over a weir and piped to a small aeration tank where, in combination with the supernatant liquor from the digestion tank, it will be aerated for about 30 min. The supernatant liquor can be drawn off at three different levels of the digestion tank in order to remove the clearest water. If

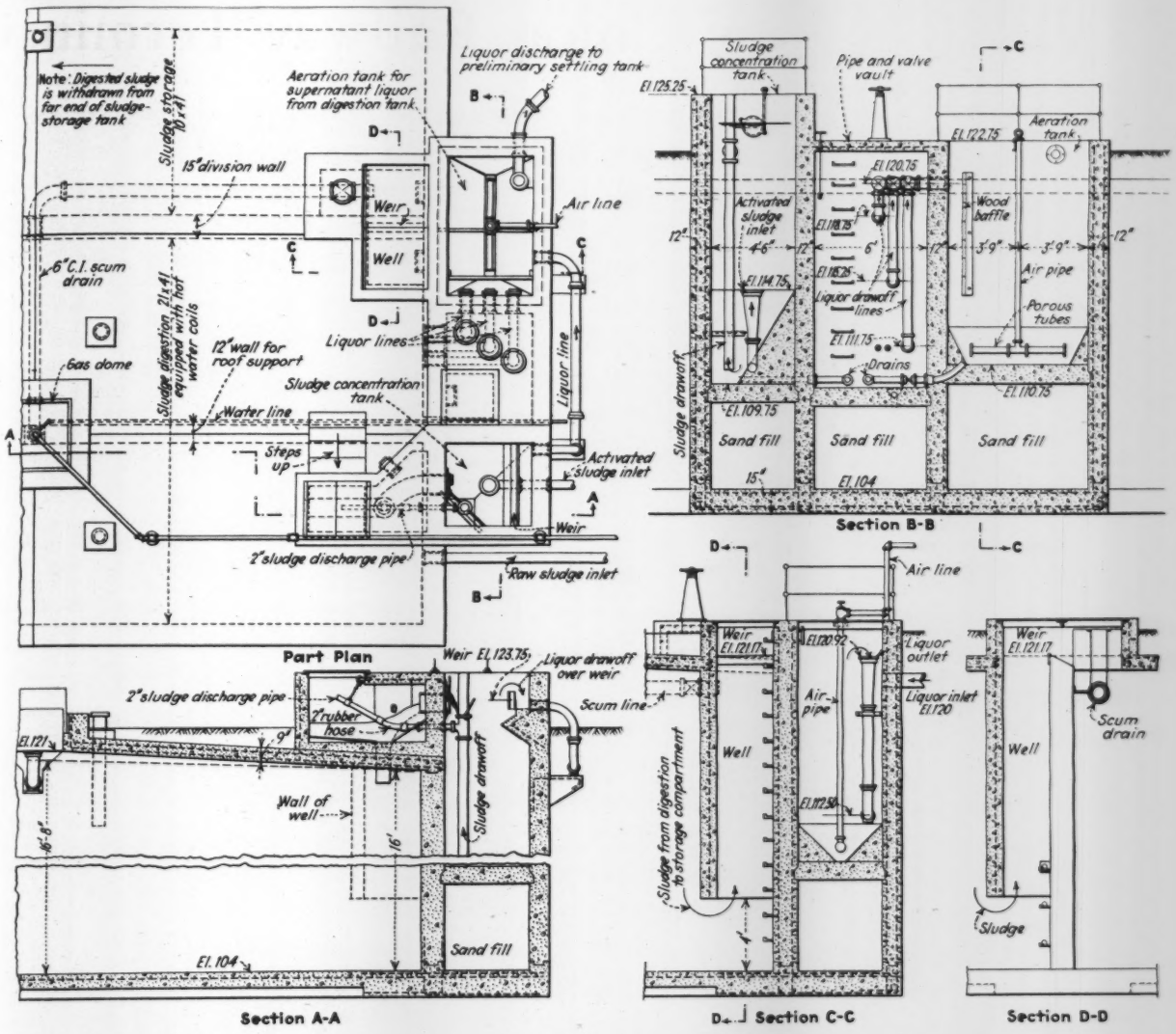


Fig. 3—Details of digestion tank and appurtenances. Special features are: the separate compartments for sludge digestion and storage, to eliminate explosion dangers; the sludge concentration tank, to decrease the volume of activated sludge going to the digestion compartment; and the small aeration tank where the supernatant liquor from the digestion and concentration compartments will be treated before it goes back to the preliminary settling tank.

necessary to sweeten this liquor, lime can be added at this point. From this tank the aerated mixture goes to the primary settling tank for the regular treatment.

In order to prevent the entrance of air into the digestion tank, the tank is designed with a division wall. The division which receives the raw sludge will be equipped with heating coils and a gas-collecting dome. The volume of this section will be 2 cu.ft. per capita. The smaller section, having a capacity equivalent to 1 cu.ft. per capita, will act as a storage reservoir. Sludge will enter it after being drawn from near the bottom of the larger tank, carried up through a well and over a weir. The elevation of this weir will be such that the digestion-tank roof is always submerged, making it impossible for air to get in and mix with the gas to form an explosive mixture. When the storage side is full, the sludge can be drawn onto the drying beds.

The plans and specifications for this plant were prepared by Black & Veatch, consulting engineers, of Kansas City, Mo. The construction is being done under their supervision by Dan Walters, Manhattan, Kan., and the plant will be ready for operation by January, 1934.

Design Features of the de Montmorency Bridge in India

AN UNUSUAL combined highway and railway bridge across the Jhelum River on the Sargodha-Khushab branch of the N. W. Railway in India is described in the *Proceedings* of the Punjab Engineering Congress for 1932.

The bridge, named for the governor of the Punjab, Sir Geoffrey de Montmorency, consists of fifteen spans, 159 ft. c. to. c. of the piers, or a total length of nearly 2,400 ft. The spans are made up of half-through type, duplicate trusses, fabricated largely from material released from another bridge. The trusses are set at 18 ft. 6 in. c. to c. of the inner trusses, and support a single-track railway line between the trusses and a 10-ft. roadway on cantilever girders at the outside of the trusses. For purposes of economy, the outside roadway widths generally were fixed at 10 ft., but as the bridge is long and as bullock carts and other slow-moving vehicles are widely used on roads in India, overtaking stations for motor vehicles are provided at every other pier by widening the roadway to 18 ft. Cantilever girders 6 ft. 6 in. deep, resting directly on the piers, form the main support for these widened roadway sections.

Cincinnati's New Union Railway Terminal

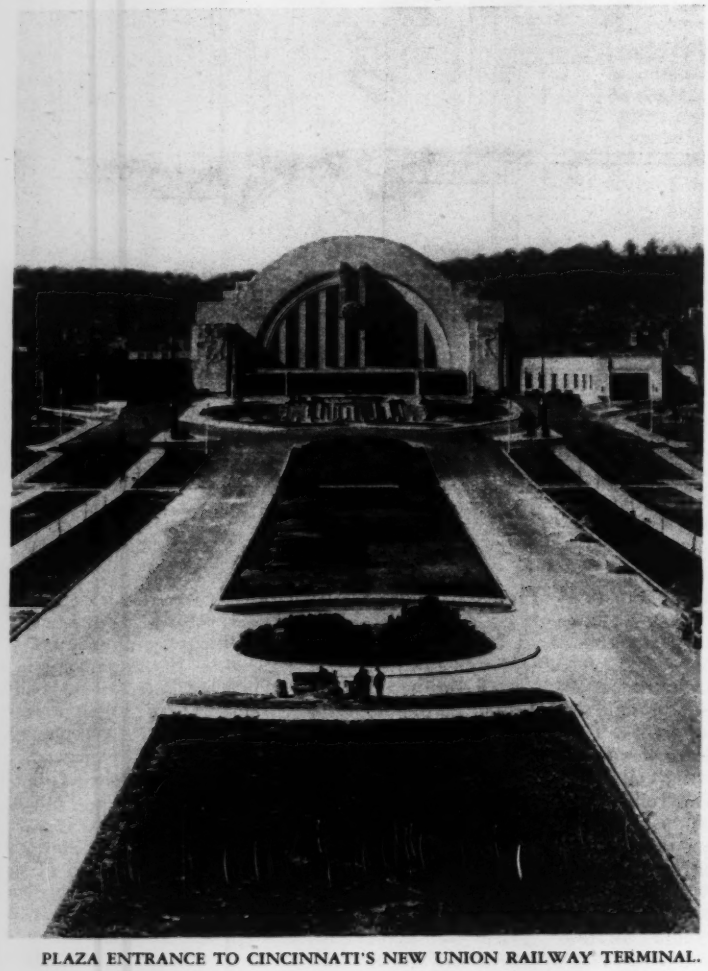
Serving seven railroads, the layout, over 6,000 ft. long, includes a magnificent station of unique structural design, an engine terminal coach yard, mail and express buildings and novel track arrangements

AFTER six years of intensive planning, design and construction work and the expenditure of some $41,000,000, the new union railway terminal in Cincinnati, Ohio, was formally placed in service late this spring. Used by all seven of the roads that serve the city—namely, the Pennsylvania and the Big Four, which enter the city from the northeast and west, and the Louisville & Nashville, the Norfolk & Western, the Southern and the Chesapeake & Ohio, which enter the city from the south and east—it comprises one of the most elaborate terminals in the country. It occupies a site of about 290 acres. The five old stations formerly used have been made obsolete by the new facilities.

Numerous articles treating various phases of the work have appeared in these pages since the first general layout story was published Jan. 5, 1928, p. 18. In the Feb. 26, 1931 issue, p. 348, the whole project was described in detail. Later articles have covered structural design of the station itself, which involves an interesting semi-dome roof (June 9, 1932, p. 817), the long-span platform roofs (June 30, 1932, p. 912), the Western Hills viaduct (Feb. 11, 1932), which carries highway traffic across the terminal at the north end, and the Gest St. underpass, in this issue, p. 525, located more than 6,000 ft. south of the Western Hills viaduct and just south of the passenger terminal. Other articles have appeared describing the railway relocation work necessary to bring some of the roads into the station, one of these jobs involving a long continuous steel-girder bridge on the south approach to the station at about 8th St. (July 28, 1932, p. 110). The purpose of this brief article is to emphasize again some of the salient features of this latest railway terminal in whose planning and construction many members of the profession took part.

In its construction severe topographical obstacles were encountered. The site, in the Mill Creek Valley, 1½ miles west of the business center of the city, was below flood level and required a 5,500,000-cu.yd. fill, for which all of the material was obtained from Bald Knob, a hill across the creek. Construction also involved the closing of numerous streets that crossed the site, leading from the city proper to the populous Western Hills section across Mill Creek. The terminal site, although over 6,000 ft. long, is now crossed only by the Western Hills viaduct at the north end and the Gest St. underpasses at the south end. The 8th St. viaduct south of Gest St. was maintained in service during construction, and provision is made for a new viaduct at 6th St., when required.

The layout, of the through type, includes not only the passenger station facilities but mail and express terminals, an engine terminal with a 20-stall roundhouse and 17 outside radial tracks, a 26-track coach yard and a power plant. The station is of the two-level type, embracing a headhouse east of the tracks and a long concourse built over the tracks, serving the dual purpose of a train concourse and a waiting room. The headhouse is about 175 ft. wide by 125 ft. deep, with a maximum ceiling height of 106 ft. and is surmounted by a semi-dome roof. Concessions and ticket windows occupy the wall space. Between the headhouse and the train concourse is a lobby in which parcel and baggage-checking functions are performed. The end of this checking lobby opens into the train concourse, a room 410 ft. long by 79 ft. wide, doors in both the north and south walls affording access to stairways and ramps leading to the station platforms.



PLAZA ENTRANCE TO CINCINNATI'S NEW UNION RAILWAY TERMINAL.

Mural paintings, aluminum trim, marble walls and glass mosaics form parts of the interior architectural treatment. In the waiting room, leather seats in aluminum frames are used. Illumination produces much of the architectural effect of the station. During the day the headhouse is flooded with daylight from the great expanse of window area in the east front. At night an unusually elaborate system of both direct and indirect artificial lighting is utilized.

A large plaza forms the entrance to the

Bowman-Park Aero Co., Louisville.

CINCINNATI, IN THE VICINITY OF ITS NEW UNION RAILWAY TERMINAL

The new Cincinnati union terminal occupies a site of 290 acres, 1½ miles west of the business section of the city. The city approach to the passenger station is (1) a large plaza carried on a structural-steel frame; beyond the station to the north is the federal post office (2) now under construction; (3) the mail terminal; (4) the express terminal; (5) the coach yard; (6) the Western Hills viaduct; and (7) the engine terminal. Across Mill Creek, which flows into the Ohio River in the foreground of the view, is Bald Knob, which supplied 5,500,000 cu.yd. of fill for the terminal area. Eighth St. passes under the south throat of the station and crosses Mill Creek on a viaduct. Just beyond is the Gest St. rigid-frame bridge.

station. This plaza is carried on a structural-steel frame so that the area beneath is available for parking. One north and south street is carried beneath the plaza.

On the station track level there are seven platforms and fourteen tracks. The platforms are 1,580 ft. long and are of concrete covered with steel canopies which are unusual in design by virtue of the 80-ft. spacing of the columns. All heavy-traffic tracks are laid with 130-lb. rail, while other tracks are provided with 105-lb. relay rails. The majority of turnouts are of No. 10 size.

The mail and express facilities are located north of the station along the east side of the terminal property, for convenient access to city streets. A new U. S. post office building is under construction in the same vicinity.

The terminal was built by the Cincinnati Union Terminal Co., H. M. Waite, chief engineer. Fellheimer & Wagner, New York City, were the architects. James Stewart & Co., New York, were the contractors for the station building.

Concrete Rigid-Frame Bridges for Railroad Loadings

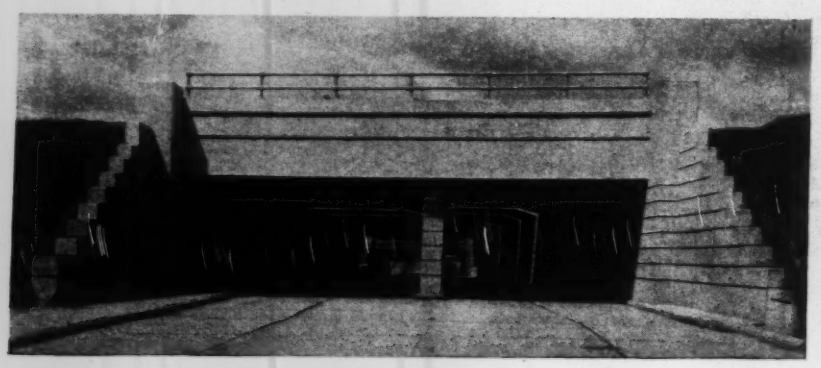
First structures of this type are located in Cincinnati on Gest St., and largest carries 23 tracks into the new Union Station

By D. A. McGavren
Designing Engineer, Cincinnati Union Terminal Co.

IN CONNECTION with the construction of the Cincinnati Union Railroad Terminal, two rigid-frame concrete bridges have been built, one carrying three tracks into a new freight yard and the other carrying 23 tracks of the south throat of the new station. These structures are believed to be the first of their type to be designed for railroad loadings, and the 23-track structure is also notable for its length, which is about 328 ft. Both bridges are two-span structures with span lengths of about 25 ft. As shown on Fig. 2, they are located on Gest St. just south of the new station. Inasmuch as the bridges are practically alike, only the South Throat Bridge, or larger structure, will be described.

Negotiations with the city of Cincinnati relative to the bridges revealed that while the center pier would be permitted, two 20-ft. roadways would be required. Permission was granted to provide only a single 6-ft. sidewalk on the south side. Having these two basic facts, preliminary studies were made which indicated that an unsymmetrical two-span reinforced-concrete structure of rigid-frame type would best fit the conditions. Investigations also showed that with pile foundations driven to uniform bearing and with a small amount of additional reinforcing steel placed at strategic locations, little fear need be felt as to the safety of this type of structure against settlement.

Fig. 1—Concrete rigid-frame bridge carrying 23 tracks over Gest St. into new Cincinnati Union Station. Bridge in background, of same design, carries three freight-yard tracks.



Frame design

In the design a Cooper's E-65 live load was used, and in addition impact, horizontal earth pressure, live-load and dead-load surcharge, traction, temperature variation and settlement of foundations were provided for. To take care of temperature movement transverse to the tracks (and to the span axis) the structure was divided into nine frames by expansion joints extending entirely through the deck, walls and footings. These joints served a secondary purpose of dividing the structure into units requiring a maximum continuous pour of about 300 cu.yd. of concrete. Care was taken to locate the joints as far as possible from tracks, and usually they were placed at light wells, which were required by the city because of the considerable length of the bridge.

The general shape of the frame cross section was determined largely by the moment and shear requirements, as limited by clearance lines. The top of the slab was sloped for drainage from the center toward each side wall. Investigation showed that, due to shear from the heavy live load, it was impossible to reduce the thickness of the section near mid-span to anything approaching the shape of section commonly used for frames carrying highway loading. The thickness of the slab of the 21-ft. north span was uniformly 9 in. less than that of the 26½-ft. south span. It would have been possible to provide an additional 2 ft. of vertical clearance for the south-throat bridge, and still maintain street clearance. But investigation showed that such an increase would have cost more, and the additional depth of fill on the structure is an advantage in cushioning the live load, in reducing noise and in providing space for pipes and conduits that may be moved at will.

Inasmuch as this type of structure is statically indeterminate, it was necessary to assume a section by approximate methods, and then to analyze the assumed structure by taking into acount the continuity of the members. From the beginning it was apparent that the foundations could not be fixed against angular rotation except at a prohibitive cost. For this reason a type of joint was developed that would serve as a hinge between the frame and the footing, and the moments at the bottom of the sidewalls and center pier were assumed to be zero. This materially reduced the cost of foundations, with only a slight effect on the cost of the superstructure.

Frame No. 3 was chosen for first and most complete analysis. Various methods of solving for the redundants were used, including two variations of the slope-deflection equations, the graphical solution given by A. Strassner in "Neuere Methoden", and the method of distributing end moments as developed by Hardy Cross. Each of these methods was quickly applied, and the results checked very well. It is the writer's opinion that speed and accuracy of results depend more on the ability of the individual and his familiarity with a method than upon a choice as between methods. Another point brought out by the writer's experience on this and other indeterminate structures is the desirability of having a checker follow closely behind the designer, at least up to the point of determining the elastic properties of the structure and solving for the redundants. Any error made prior to this point will vitiate the results of a great amount of work that follows and should be quickly caught.

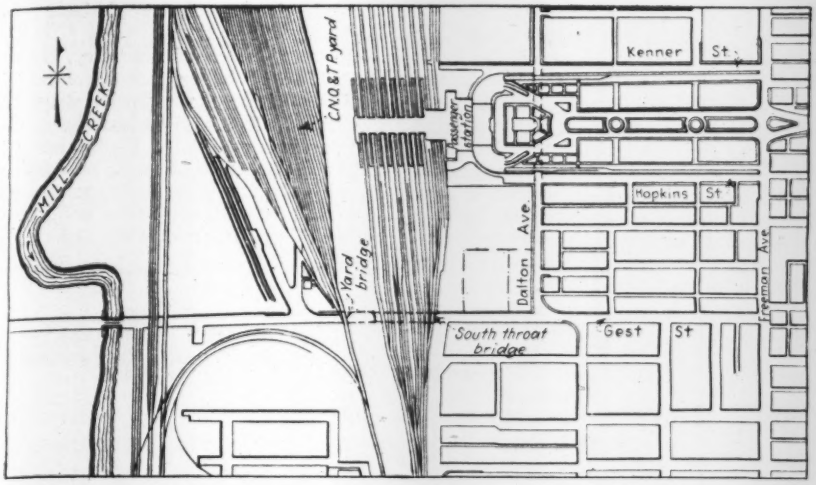


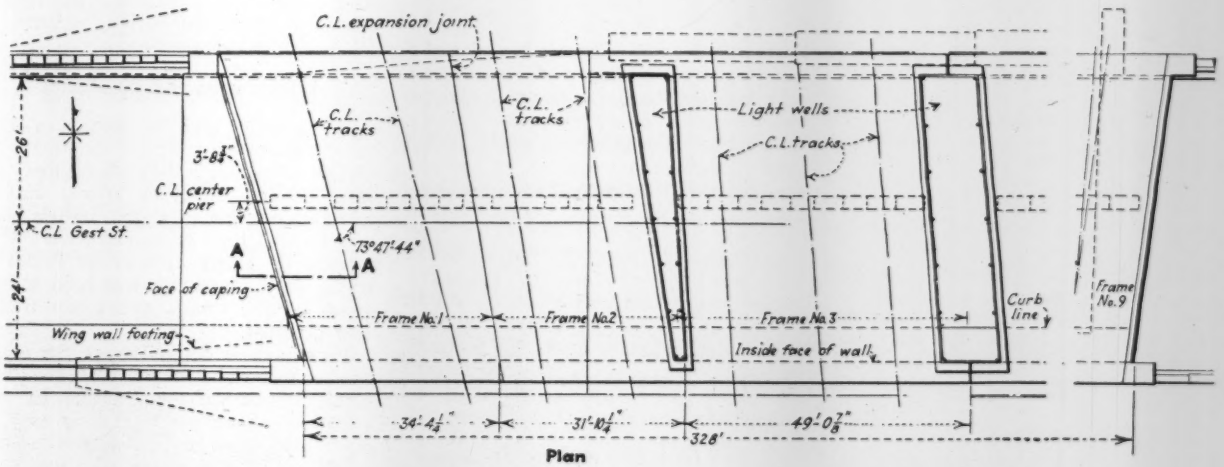
Fig. 2—Gest St. underpass bridges are located several blocks south of the new Cincinnati Union Station.

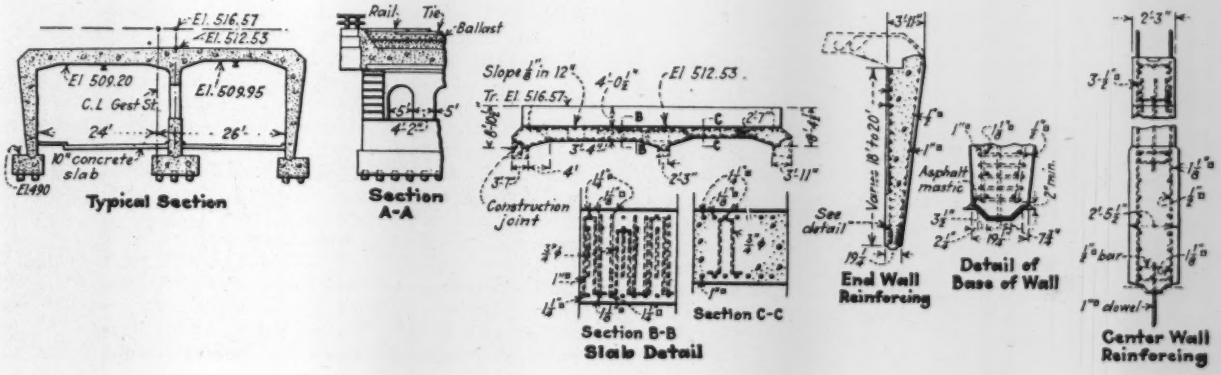
For frames other than No. 3 it was found that by a slight change in thickness, to compensate for varying height, the elastic properties of the side walls could be kept the same as for frame No. 3. This meant that for vertical loads and temperature changes the moments were the same as for frame No. 3, and only the horizontal loads due to traction, earth pressure and surcharge need be investigated.

The frames are all more or less skewed, up to a maximum of about 16 deg., and a rigid analysis would have required the use of formulas of the type developed by Professor Rathbun. An aproximate analysis was made to determine the effect of the skew, and it was compensated for by the use of ¾-in. transverse distributing bars in the slabs, top and bottom.

Fig. 3—Details of two-span, barrel-type, concrete, rigid-frame bridge designed for railroad loadings. Because of extreme length (328 ft.) light wells are required, breaking up the barrel into nine frames, each about 35 ft. wide. End walls and center pier are designed to transmit no moment to the foundations.

Influence lines were developed for the corner moments and for intermediate moments at a number of points equally spaced in each span. Moments were also determined for a uniform horizontal load against each side wall separately, a triangular load against each side wall, and a horizontal load applied at the center of the slab. From these, moments at any point from any combination of loads were quickly determined. Complete maximum positive and negative moment and shear diagrams were drawn, from which the concrete stresses and required steel areas were determined. In combinations of loadings, including traction, stresses 25 per cent higher than normal were used; the excuse for this is that the structure is comparatively short and, with a ballasted track only a part of the computed traction will be taken by the frames. This condition does not govern the design in any case. For combinations of all other loadings with a settlement of any one foundation, stresses 50 per cent higher than normal were permitted. This condition governed only in the case of positive steel in the slab, near the center pier and side walls. One interesting fact brought out by the investigation for settlement of foundations is that while a relatively small vertical





settlement of one foundation produces a large increase in the stresses in the structure, at the same time it greatly reduces the load on that foundation. This means that so far as vertical settlement is concerned, the structure tends to equalize the loads on the foundations. This line of reasoning does not apply to horizontal movement of the footings, and they were conservatively designed to resist such movement.

Side walls were designed for a combination of direct stress and bending. The negative steel in the outside faces of the side walls was carried around with a long radius bend into the top of the slab, where it spliced with the negative slab steel. Due to the necessity of splicing this steel near a point of maximum moment, hooks and an extra length of embedment were freely used.

Because of the narrow width of the side walls at the top of the footing and because of the concentration of direct stress at this point, the wall was reinforced with a series of closely spaced ties, and the lower 2 ft. was made of a richer mix than the rest of the frame. The change of mix was made without interrupting the pouring, in order to avoid a construction joint.

At the locations of light wells, the side walls were extended beyond the footing and the deck slab to a joint usually located at the center of the light well. Center piers are discontinuous at light wells. They are also relieved by arched openings on close centers. This was done to improve the light distribution and to relieve the tunnel effect that exists in a structure of such length.

Foundations

An existing underpass with long approaches between retaining walls was so located as to interfere with the foundations for the new structure. Due to the presence underneath it of an old stone outfall sewer (12-ft. diameter), the previous bridge, consisting of precast concrete slabs on concrete abutments and center pier, had been founded on a monolithic reinforced-concrete slab, supported on precast concrete piles driven wherever possible to miss the sewer. This bridge had been carrying railroad traffic for about ten years without any indication of settlement. Frames No. 8 and 9 occupy approximately the location of this old concrete mat but extend beyond it somewhat on the east, west and south. The grade of the new street is several feet higher than the old grade, and the decision was reached to leave the old foundation slab in place, constructing above it a new reinforced-concrete slab conforming to the shape of frames No. 8 and 9. The space between the top of the old slab and the bottom of the new one was filled with selected gravel, well tamped. The new slab was further strengthened by driving 26 new concrete piles outside the limits of the old mat. This arrangement gave a rigid foundation for frames No. 8 and 9 without disturbing the sewer.

The approach walls of the old structure were lightly reinforced concrete walls of gravity section and were without piles. For frames No. 1 to 5 inclusive, where the old walls were of low height, they were removed, and separate new foundations were constructed for the south wall, center pier and north wall respectively. For frames No. 6 and 7 it proved more economical to combine the footings for the center pier and the north wall, as by so doing much of the masonry of the old walls could be left undisturbed.

All foundations, except as noted above for frames No. 8 and 9, rest on cast-in-place concrete piles, driven to a resistance of 43 tons as determined by the *Engineering News* formula. The maximum design load was 35 tons per pile. To aid in developing the necessary reactions for horizontal loads, the footings, where separate, were poured against wood sheetpiling left in place against undisturbed earth.

Concrete and finish

All concrete except that in the lower 2 ft. of the side walls and center pier was designed for an ultimate strength of 2,500 lb. per sq. in. at 28 days. As explained above, the lower 2 ft. of the side walls and center pier was of a richer mix, designed for an ultimate strength of 3,000 lb. per sq. in. Actual strength, as determined from samples taken during construction, ran well above the design strength. Studies showed that the use of a higher-strength concrete was not justified, unless a higher unit stress for steel were also adopted. This was impracticable because it would have required a spacing of reinforcing bars that would have been too close.

Due to the lack of symmetry, it was thought to be better to conceal rather than emphasize the essential shape of the frame. For this reason the facias and parapets are plain. To balance the rather great height of facia, an open 4-in. pipe railing with ball-type fittings was used in preference to a solid concrete railing. Faces of walls and center pier are relieved by horizontal rustication and by occasional narrow pilasters. The wing walls, paralleling the street, are of conventional design, continuing the horizontal rustication.

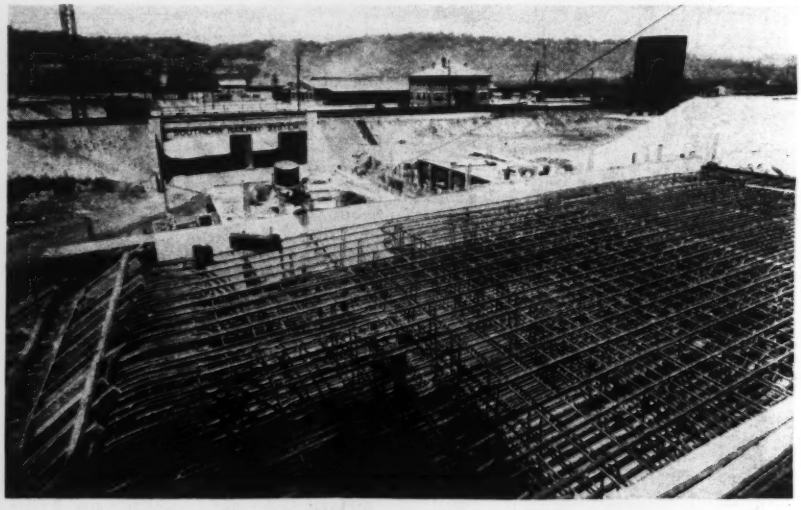


Fig. 4—Steel in the slab of frame No. 2 of the South Throat Bridge over Gest St., Cincinnati. In the background is the freight-yard bridge, also of rigid-frame design.

Conclusions and personnel

While this type of structure has proved eminently practical for this particular situation, it is realized that the same results cannot be blindly anticipated for another location. Its use here was favored for its freedom from interference by either railway or highway traffic, as the structure was built in advance of the tracks, and street traffic was diverted.

Its saving is derived from the economy of material resulting from complete continuity of walls and slab. In any situation where approximately similar conditions occur it is well worth consideration in competition with the more usual types of structure.

For the Cincinnati Union Terminal Co., H. M. Waite was chief engineer, George P. Stowitts, engineer of construction, and Pusey Jones was engineer of design. The design was developed by A. F. Hedman, under the personal supervision of the writer. Roger Baer was district engineer in charge of construction, and G. Cannon served as resident engineer.

The C.N.O.&T.P. yard bridge was built by the C. G. Kershaw Contracting Co., Birmingham, Ala., and the South Throat Bridge by the Kerpen Construction Co., Cincinnati, Ohio.

Stabilizing Gravel Roads, Onondaga County, N. Y.

Moisture regulation by calcium chloride in stabilized mixtures of local soils — Theory of stabilization—Results of calcium chloride tests

BEGINNING in 1932 with a 50-mile program, Onondaga County, N. Y., has under construction this year a system of 285 miles of gravel-surfaced roads bound with calcium chloride. These roads are graded to standards required for paving; and drainage, structures, guard-rails, etc., as for a paved road, are provided. The gravel surfacing is 20 ft. wide and 3:9:3 in. in section. Its difference from the usual gravel construction is in the induration of the surface by calcium chloride. Penetration of the surface layers by the chemical develops moisture-film cohesion and consolidation of the clay, which with the high internal friction of the sand gravel produces under traffic a notably hard and stable crust increasing in depth with age. This theory of induration is outlined in a succeeding section.

Run-of-pit gravel from local deposits is used. Where this gravel does not have balanced grading, clay or shale binder or sand is added. Commonly the roadside loam meets the requirements. There is no attempt at fine grading by screening and remixing. Good judgment of the pit composition and observation of how it packs under traffic are the guides to such combination of soils as are found necessary. After the surfacing is spread, it is rolled and subjected to traffic until it is fairly well traffic-bound. The spreading is being done by hand, as the new roads are a part of a work-relief program for the city of Syracuse and Onondaga County. When preliminary consolidation by traffic is obtained, the surface is bladed, the calcium chloride in flake form is spread at the rate of 1½ lb. per square yard, and the material that has been worked to one side is worked back onto the road. This, in general terms, is the construction procedure.

Maintenance practice

Maintenance is a process of surface honing and of re-treatment at intervals with calcium chloride. Both are done only when needed and at no set intervals. Re-treatment once or twice a year is generally sufficient. This consists generally of applying ¾ lb. per square yard of chemical, after honing the old surface, and of working the material cut away back over the roadway as in original construction. Care is taken to perform the intermediate honings after rains so as not to waste the calcium chloride in the soil. Following rain, the chemical is carried into the deeper surface layers in which it rises again by capillarity as the gravel dries out.

With the surfacing material and under the conditions in Onondaga County the calcium chloride roads show generally a remarkable degree of cementation. Travel over a number of separate projects a year old and of more recent construction, with frequent stops for close inspection, disclosed a surface clear of loose mulch or dust-producing fines. Embedded pebbles and even stones larger than the hand were firmly bonded into the finer material. Tests with a knife blade showed a degree of surface induration of almost concrete-like resistance, and tests with hand and foot showed a non-skid texture. On a dry warm day a hand pressed on the surface gave a consciousness of dampness, and this was also disclosed by the fragments loosened by the knife blade. All appearances indicated that the surface would shed reasonable amounts of rain without material softening or wash.

As stated, the permanent way is constructed to standards required for paving. As the new roads are part of a work-relief program, ditching and grading are hand-labor operations except in deep cuts where power excavators are worked. Any considerable hauling is by county trucks and hired teams. The roadbed is graded 26 ft. wide with standard side ditches. Trucks bring in the gravel surfacing, and it is spread by hand. About 1,600 yd. per mile is required, and about 10 tons per mile of calcium chloride for the first treatment. With hand labor by unemployment relief forces, the surfaced roads are costing $6,000 to $8,000 a mile.

Theory and test data

The theory of the calcium gravel road is: If a gravel-sand mixture, graded to obtain maximum interlocking and supplemented by a proper amount of cohesive material such as clay, is kept constantly damp, it consolidates and hardens under traffic and continues highly stable against lateral displacement. The function of calcium chloride treatment is to maintain the proper moisture condition.

In general, the stability of a soil against lateral displacement is, as late

Typical highways of Onondaga County, N. Y., before improvement and after standardizing roadbed and surfacing with a stabilized gravel.

Grading an Onondaga County road by hand labor recruited from unemployment relief lists; 6,000 men are now working on 285-mile program.

soil investigations have shown, a function of internal friction and of cohesion. In road-surfacing mixtures of the sort being considered the sand gravel supplies the internal friction; its amount, or the resistance of the particles to sliding over each other, depends on the amount of frictional material, its degree of compaction and the grading, shape and size of the individual particles. The clay supplies the cohesion. It is maximum when each particle is surrounded by a thin film of water. The theoretical clay content of a surfacing mixture is that amount which, expanded by water to maximum cohesion, fills the voids in the sand without unseating the sand grains from the position in which maximum internal friction exists. This presumes constant moisture in the clay, and the purpose of the calcium chloride is to insure it.

The behavior of the chemical in a surfacing mixture is theoretically as follows: In a hot dry spell, particularly if prolonged, the calcium chloride has been brought close to the road surface by capillary rise and evaporation. With rain, the first water absorbed by the road carries the salt in solution into deeper layers, the clay in the surfacing material expands to fill the voids, and further rainfall runs off the road. Following the rain, evaporation begins drawing up the moisture from below and bringing the calcium chloride with it. This goes on until the condition at the beginning is restored, with the calcium chloride at a moisture concentration which balances the humidity in the air. Incidentally, the action described explains the reasons for planing treated roads after a rain when the calcium chloride is below the surface soil affected.

Observation of experimental calcium-chloride-treated roads under the direction of the Highway Research Board, to determine causes of loss of calcium chloride, has enumerated: (1) base exchange due to acidity in the soil; (2) washing out by rainfall and runoff; and (3) dissipation due to maintenance blading and honing. The last cause was reported to be the most important. As to the capacity of calcium chloride to retain moisture in the soil, other experiments showed that, subjected to a drying temperature of 80-100 deg., a treated soil lost all its moisture in 27 days and an untreated soil in 3 days. Tests of dust loss on roads under regular traffic showed 50 per cent less dissipation on treated roads.

The basic information being gained of roads of the type under consideration comes from the soil stability investigations by the Bureau of Public Roads and some private and municipal laboratories. The natural materials in any community, where soil surfacing is a consideration, are of sufficeint variety to make possible combinations that will give maximum stability. Laboratory procedure and apparatus have been developed by the Bureau of Public Roads and are available to other agencies that will determine these combinations. The task is neither complex nor abstruse to trained physical and chemical laboratory operatives; in fact, apparatus and methods are being simplified for more general use.

General discussion

The fundamental requirement of traffic-enduring road surfaces of available natural materials is stabilization of these materials by combination into a semi-solid constant-volume slab. This soil stabilization is the basic factor in the signal success of the Onondaga County gravel-sand-clay-calcium roads. Accounts of the soil-calcium roads built in the Canadian provinces, many states and particularly in Michigan, furnish other definite evidence. Calcium chloride, when applied to a stabilized-soil road surface, acts as a primer to attract moisture to the capillary ducts, and by its hygroscopic nature sets up a surface tension, or vapor pressure, which limits evaporation of soil moisture into the air. It aids therefore in regulating a vital element—moisture—of a stabilized soil. As a corollary, waste of road material by dust dissipation is reduced.

Practical considerations enter the problem of soil stabilization for road surfacing. It is one matter to adopt the method in locations like Onondaga County where nature has supplied materials that easily produce stable combinations, and another matter in the gumbo-soil states in parts of the Mississippi valley. These facts do not censure soil-stabilization theory or practice, they merely express the principle that is fundamental to sound engineering—that technical and economic judgment must determine road planning and investment in any general situation. All situations do not warrant undertaking soil stabilization for purposes of road surfacing.

In the Onondaga County road operations, outstanding praise is merited for the adoption of progressive construction. All the road structure except the surfacing is permanent investment. The surfacing offers, when traffic warrants a higher-type pavement, a sub-base whose bearing power and stability can be considered in cheapening the design of the new surfacing.

The operations in Onondaga County are being carried out under the direction of R. B. Traver, county superintendent of highways, Syracuse, N. Y.

Ten Business Problems of Contracting

VII—The Costs of Owning Equipment

Costs of owning equipment divide into wear and tear, repairs and operating expenses, functional adequacy and moving—When to purchase new equipment

By J. L. Harrison
Senior Highway Engineer, Bureau of Public Roads, Washington, D. C.

DURING the past twenty-five years the development of machines capable of performing specific kinds of work, either more cheaply or more perfectly than such work can be performed by hand, has been rather rapid. As a result the relative amount of work done by machine has increased very considerably. In the construction field, which has been affected perhaps as much as any by this trend toward mechanization, there has been a progressive abandonment of hand methods and animal power for more modern and frequently more expensive power-driven equipment, and this progressive abandonment of hand-labor methods has now reached such a stage of advancement that no construction work of much consequence would normally be undertaken without modern equipment.

From the general financial standpoint this has required an increasing investment in fixed assets—a matter discussed in the previous article. From the construction standpoint it has meant that an increasing fraction of construction cost is generated by the equipment.

This second aspect of mechanization—its relation to the cost of handling construction work—deserves rather careful consideration, for in spite of the relative importance of equipment expense, which in some lines now exceeds payroll expense, as a rule less is known about it than is known about any of the other elements of construction cost. This situation arises from the fact that equipment develops a variety of expenses, none of which are very definitely predictable in advance. In its turn this lack of definite knowledge of these costs is traceable to the fact that equipment has only recently reached anything approaching stability in design. In the past every new model has been so modified and improved that costs developed on preceding models are obsolete almost as soon as they are collected.

Cost of wear and tear

In the ordinary discussions of equipment costs it is customary to include wear and tear, repairs and operating expense as the matters of major importance. To these the writer feels there should be added functional adequacy and dependability. For some purposes the cost of moving equipment from job to job must also be considered. These will be discussed in the order in which they have just been noted.

Every machine has a limited useful life. Use results in wear, and eventually wear renders a machine unfit for further use. As capital, the value which a machine has when new is rather rapidly dissipated as the machine is used. This effect is covered under the general term "depreciation"; and, by custom, an amount roughly agreeing with the effect a given amount of use has on the probable useful life of any piece of equipment is charged against the jobs on which the equipment is used. At regular intervals this should be set up on the books of account as a reserve—that is, as a subtraction from the useful life and therefore from the value of the equipment.

Here the contractor meets his first problem in dealing with the cost of using equipment. There is no really reliable information as to the rate at which equipment wears out. To obtain anything that approaches reliability in this field, it is necessary first to have reasonable stability in design and then to have a considerable period in which to collect information as to what the ordinary useful life is under normal working conditions. The rate at which equipment has been improved during the past fifteen or twenty years has precluded the collection of exact information of this sort.

But while there is no very exact information on the rate at which contractor's equipment depreciates, the fact remains that it does depreciate as it is used, and that the amount of this depreciation is both a charge against the job on which the work is done and a charge against the capital invested in the business. Or, to state this matter a little more clearly, unless the value subtracted from the equipment on account of its use is taken out of the amount received for the work performed and transferred to the capital account, there is a corresponding depletion of the capital account. As a business man the contractor must, therefore, estimate the depreciation on the equipment he uses and charge whatever amount his judgment dictates is reasonable against the projects handled, this charge being treated as a part of the construction cost. Moreover, as no really reliable information on rates of depreciation is available to him, sound business judgment dictates that these charges shall err on the side of liberality if at all. Depreciation is a fact which cannot be avoided. If the charges made on account of it are too high, the most that can happen is that the capital account develops an actual value somewhat in excess of book value. To make these charges too small, whether this is done consciously or unconsciously, is to commit slow but certain financial suicide.

Cost of obsolescence

But while, if the amount of equipment owned is reasonably in harmony with the kind and the volume of work handled, and if this equipment is replaced often enough to insure a good dependability factor, the depreciation caused by fair wear and tear should be the largest item in the loss of value incident to the ownership of equipment. But it is not the only type of depreciation that the contractor must consider. In any period during which improvements in an art are rapid, obsolescence enters as an influence that tends to wipe out the value of plant and equipment without much regard to whether it is used or not. When the writer was a boy, all hauling on construction work was done by teams and wagons. The design of these wagons changed slowly, if at all. As a result, a contractor could place his wagons in good storage one year, and if they were given only moderate care he could take them out again a year later, or five years later, with every reason to expect that they would prove as useful as when they were put into storage. In short, obsolescence was practically zero. Construction, as an art, was advancing slowly if at all.

During the present century—more particularly during the past two decades—construction as an art has been advancing very rapidly. As a result the contractor who placed an important piece of equipment in storage a few years ago now often finds it so obsolete that even though it is still in good condition it nevertheless would prove quite unprofitable to use it. As equipment it has become a total loss.

Here the contractor faces a difficult problem, for the rate at which obsolescence occurs evidently is variable, from

which it follows that the determination of this rate becomes a matter of judgment. At times the rate of obsolescence falls practically to zero, where it was in many subdivisions of the construction field some forty or fifty years ago. At times it is very high, as it was when steam power plants were being replaced in the construction field by gasoline power plants, with the result that those who owned such equipment were confronted with the fact that almost new equipment of the older designs was so far outclassed by new equipment of new design as to render it all but valueless. Just at present, as far as the writer is able to discern, the rate of progress in equipment design is again much reduced—that is, a period of greater stability in equipment design and in construction practices appears to lie ahead. If this proves to be true, the effect of obsolescence will be less and the allowance for it may be corresopndingly reduced. On the other hand, if the immediate past is accepted as a criterion of the immediate future, it will continue to be necessary to allow for losses in equipment value on account of obsolescence at a rate that is about as high as the rate caused by fair wear and tear.

As long as the rate at which obsolescence is destroying equipment values does not exceed the rate at which fair wear and tear is destroying them, the contractor who has no unused or under-used equipment does not need to give obsolescence much consideration, for the effect of obsolescence is not an effect that is to be added to the effect of wear and tear. Rather it is an effect running, as it were, in parallel with wear and tear and which, as to used equipment, is to be determined and set up in the accounts only if and when it is destroying values faster than use is destroying them.

But because the effect of obsolescence continues whether equipment is used or not, the rate of obsolescence is of vital importance in determining the value of under-used and unused equipment. In a previous article there has been some reference to the fact that unused equipment is invested capital on which nothing is earned, and that sooner or later the capital so invested usually proves a total loss. The unescapable effect of obsolescence is the principal cause of losses of this character. Moreover, the loss of value which is caused by obsolescence is as effective in destroying the value of under-used or partly used equipment as it is in destroying the value of equipment which stands completely idle. On this account, if a contractor, as a business man, is to know where he stands financially, it is essential that at regular intervals he determine and set up reserves to cover all of the loss in value that has occurred in his partly used and in his unused equipment—the effect of obsolescence on its actual value as equipment—just as carefully and just as fully as he endeavors to set up the cost of depreciation due to wear and tear.

Quite obviously charges of this sort cannot be offset by charges against projects, for they do not represent use. They must be made first against profit, but in the event profit is inadequate, they must be charged against capital. In no event is it safe to ignore them. To do so results in a statement of financial position which even to the contractor himself is likely to prove deceptive, the basic cause of much financial difficulty which a correct statement of financial position could have avoided.

Cost of maintenance

Beside the loss of equipment value due to wear and tear—ordinary depreciation—the cost at which construction is handled necessarily includes the cost of maintenance and repairs on the equipment required in its execution. Here again the contractor, as a business man, faces a difficult problem. All types of equipment require some maintenance and generate more or less expense in the way of repairs. This latter expense increases from year to year as long as the equipment is used.

Logically the probable cost of maintenance and repairs during the probable useful life of any piece of equipment should be determined in advance, reduced to a monthly or daily rate and then, like depreciation, charged against construction work on the basis of the use made of the equipment. That this course is not more generally followed is due to the fact that equipment design has been changing so rapidly that it has been quite impossible to determine the probable cost of maintenance and repair on any kind of construction equipment with such accuracy as to make this practice altogether satisfactory. As a result, the more common practice is to charge these costs as they occur to the jobs on which the equipment is in use when they occur. As the capital account is not affected by this procedure, it usually does no great harm. The greatest objection to it lies in the fact that the apparent profit secured on jobs where new equipment is used is thereby made somewhat too great, for maintenance and repair costs on new equipment are negligible, and that when old equipment is used profits are correspondingly reduced, because maintenance and repair costs on old equipment are high. Where those types of work which require the use of a good deal of expensive equipment are being handled, and more particularly when the general margin of profit is low, it is not uncommon to find that these variations in the cost of maintenance and repairs on equipment cause enough difference in apparent profit to be somewhat confusing, and in occasional cases they cause contractors to withdraw and extend what appears to be profit on jobs on which new equipment has been used only to discover later on that a considerable part of the apparent profit should have been treated as a prepayment on repairs that it would be necessary to make at a later date.

Operating costs

In the writer's experience, operating expenses—principally the cost of fuel—are always charged to the jobs on which they are generated. This is reasonable and entirely proper, for these charges do not change to any considerable extent during the ordinary useful life of equipment. The amount of fuel a mixer or a truck or a shovel will use per hour or per day can be, and as a rule is, pretty definitely known, and any important variation in it can be readily detected, and any repairs or adjustments which are required in order to correct the excessive use of fuel can be made without much difficulty. Operating cost can, therefore, be predicted with a reasonable degree of certainty and pretty accurately controlled. On this account the costs which are involved here give contractors relatively little trouble and sedom are the cause of important losses.

One exception is the rather common loss of gasoline on account of pilfering. It is so easy for workmen on the job and for those who live near it to drain a little gasoline now and then from unguarded trucks or from the tanks of other gasoline-driven equipment that unless a good deal of care is used the loss of gasoline from this cause may run to rather surprising totals. Such losses can be quite entirely avoided by the use of proper care, but the expense involved is of some consequence.

Cost of functional adequacy

Functional adequacy (the ability of equipment fully to meet the requirements to be made of it) and dependability (the ability of equipment to function without delays for adjustments or repairs) are two of the most important attributes of equipment. Together they cover the fact that equipment, to be fully satisfactory, should be able to do all that conditions require and to do this all the time. Very little equipment can meet this standard even when new; and none, so far as the writer knows, maintains this high standard for long. Ordinarily this situation is accepted as unavoidable, which it no doubt is, but as the effect of a lack of functional adequacy and of any lack of dependability on the cost at which work is done may be considerable, these aspects of equipment should receive a great deal more attention than they usually are given, and it should be more widely appreciated, particularly as to dependability, that the extra cost of construction caused by the use of equipment having a low dependability factor may easily exceed all other costs generated by such equipment.

That this is the case is due to the nature of construction work. Practically all such work involves one or more series of inter-dependent operations handled in regular sequence. To be an organization at all worthy of description as such, each of these operations must be so equipped and manned that its capacity is in balance with that of all other operations in the series. As an illustration, on a grading job, if the organization is properly balanced, there are enough hauling units to handle whatever material the shovel can dig, enough men on the dump to spread the material the trucks deliver and enough rollers to compact the material the dump crew spreads. But with an organization of this sort—and all construction organizations worthy of the name are based on one or more series of this sort—it is perfectly obvious that anything which stops one operation tends to have the physical effect of stopping the whole job and that this remains true whether there is any visible cessation of activity in other operations or not. The very fact of equality in output capacity as between successive operations makes this result inevitable. If the shovel is stopped for fifteen minutes for a minor adjustment, obviously output is correspondingly reduced. But it is equally true that if the shovel and the hauling equipment are in balance, taking out a truck for half an hour also cuts production accordingly. Illustrations could be multiplied almost without limit, but to give them would merely be to add emphasis to the fact already stated that anything which delays one operation of a balanced series tends to delay all operations in the series and correspondingly to reduce the job output.

But in so far as this is true, and it is a principal of wide applicability in the construction field, anything that causes even a momentary equipment delay, whether for repairs or merely for the purpose of making minor adjustments, tends to subtract from the job output for that day. If primary equipment, such as the mixer on a paving job or the trenching machine on a pipe-laying job or the shovel on an excavation, is involved, the subtraction from the total working time is apparent and the reduction in output perfectly obvious. If secondary equipment is involved, the effect is not as obvious and may not be as serious. Still the tendency exists and quite often the ultimate result is the same. But—and here is the nub of the situation—the cost of all small losses of time must, as a rule, be absorbed by the contractor. If the mixer loses five minutes here and ten there for minor adjustments, the output is reduced accordingly, but payroll and other charges are not. The extent of the losses caused by repairs and adjustments, made while the job is running, is much greater than is usually supposed. Even at present-day prices, delays at the mixer, and all other delays which have the effect of shaping production, cost the contractor on an ordinary paving job from 60 to 70 cents a minute. A mixer that loses 15 minutes a day on account of adjustments and minor repairs is, then, taking about $10 a day out of what otherwise should be profit. This is no small amount of money in these days of narrow margins, but a mixer must be in pretty good condition to show average time losses as small as this. A great many of these machines lose half an hour or more a day, and even greater time losses on this account are of common occurrence in the field.

Nor is this situation peculiar to mixers. It applies to all types of equipment, and as to other than relatively new units often is the largest item in the cost of using such equipment.

Budgeting dependability

There is no set rule as to when a lack of dependability may be expected to generate burdensome expense. Practically all construction equipment will go through the first year of active service without generating important expense in this field. A good many machines show reasonably satisfactory dependability for two or three years, some for longer periods. Usually dependability falls as repairs costs mount, though even this is by no means a fixed rule, for rather frequently modern equipment requires repeated minor adjustments before major repairs are made.

Dependability is of somewhat more vital importance in key units—that is, the units about which the production organization is built—than in the subordinate units, for any time lost by the key unit is pretty certain to act as a subtraction from the working day and so from the amount of work done on the job, taken as a whole. On this account both the functional adequacy and the dependability of key equipment are vital to the contractor, for when margins of profit are narrow, profitable operation is practically impossible unless key equipment can be depended on to produce the proper output and to produce it without delay. On this account, key equipment should usually be replaced rather more often than secondary equipment, the direct savings which result from high dependability and complete functional adequacy being quite sufficient to justify this course.

Both the direct value of dependability and of functional adequacy can be determined by the rather simple practice of recording (usually in minutes) all delays caused by any deficiencies in these respects and multiplying these time losses by the normal job expenditure per minute. In determining the normal expenditure per minute, the cost of materials should, of course, be excluded, but other costs, such as labor, depreciation, operating expense, etc., should be included.

Besides the direct cost of any lack of either dependability or functional adequacy, poor equipment causes a good many other difficulties which tend to affect the cost at which construction can be handled. One of these, and rather an important one, is the psychological effect. "A man," some writer once said, "may be better than the clothes he wears, but he has to prove it." In the construction field a contractor may be better than the equipment he uses, but it is extremely difficult to make his men believe it! It's hardly worth the effort!

A matter rather closely related to this one is the fact that good production and the closely related fact of low production cost require good organization. It is all but impossible to develop a smoothly functioning organization with the high average output of which such an organization should be capable if the work must be stopped every little while to repair some piece of equipment. The men lose interest in their work, develop a slower stride, become disgusted and often leave entirely.

Costs in these fields are quite intangible, but nevertheless so very real that any contractor who is trying to work with wornout equipment or who is tempted to try to do so, will find it much to his advantage to give them serious consideration. Usually the result will be a conclusion that new equipment should be secured. Incidentally, it may be remarked that when times are bad there is a very general tendency to keep old equipment rather than to buy new equipment. While a contractor's financial position may force him to follow this course, the result is very likely to be rendered unfortunate by reason of the general increase in construction cost, which appears to be the unavoidable result of the use of equipment that is not in good condition. In short, it always is more profitable to work with good equipment than with equipment which has developed a low dependability factor—so definitely so, in fact, that even more attention should be given to this fact when times are bad and margins small than when times are good.

Cost of moving equipment

The cost of moving equipment from job to job is not often considered a part of the equipment cost, yet this is what it really is. There are endless ramifications of this aspect of the cost of using equipment in performing construction work, only a few of which can be discussed here. Of these the first is the effect on the cost of handling small jobs. Rather often, if the effect of the cost of moving heavy equipment is considered as a part of the cost of performing the work rather than as an incidental cost, it will be found that even long-abandoned hand methods are cheaper than machine methods. Each job is a problem in and of itself. Still

it is a problem and it ought usually to be considered as such. The habit of using equipment on all sorts of work under all conditions has become so fixed that the possibility that this may not be the cheapest way to handle it does not receive the attention it deserves.

The above applies more definitely to small jobs, but occasionally it applies to jobs of some size—more particularly when equipment must be moved some distance. The man who must pay $10,000 to get his outfit onto a four-mile concrete paving job that others can reach at a quarter of this sum cannot expect a profit on the work in times like the present. Margins are far too narrow to permit of it. The writer has seen just this done not only once but repeatedly, the evident cause having been a failure to appreciate the fact that the cost of getting equipment to and from a small job may generate prohibitive unit-equipment charges.

In general, the cost of moving large equipment units from job to job is a good deal higher than the cost of moving small units. True enough, the large units can usually produce at a lower unit cost if the nature of the work is such as to permit of utilizing their larger capacity. Nevertheless, when the higher costs of moving from job to job are considered, a good deal of the advantage that large units seem to have often disappears. If, in addition, the prospect of securing a volume of work that is consistent with the size of really large equipment units is considered, the very general advantage to be derived from purchasing units of moderate size will be apparent.

In short, it is found that the size of any piece of equipment that the contractor purchases should harmonize with the nature and the volume of work generally handled, rather than with the nature and the amount of work offered by a single project, unless the equipment is purchased for and its cost liquidated by the project for which it is purchased—as presumably will be the case, for instance, with special equipment that has been secured for the Boulder Dam construction.

Cost of delayed turnover

Equipment is worn out and ought to be replaced whenever the average annual cost of using it can be reduced by securing new equipment. The cycle generated by equipment always follows a course more or less similar to that indicated in the following hypothetical example:

FIRST YEAR	
Cost of unit new	$8,000
Operating cost (no labor included)	1,000
Repairs	100
Losses due to lack of dependability	200
Total	$9,300
Probable value at end of first year	$5,500
Total cost of use made of machine during first year	$3,800

SECOND YEAR	
Total cost of machine at the beginning of second year	$9,300
Operating cost	1,000
Repairs	300
Losses due to lack of dependability	1,000
Total	$11,600
Probable value at the end of the second year	$3,500
Total cost of use made of machine during first two years	$8,100
Average cost of use during first two years	4,050
Increase in cost of second year's use as compared to first year's use	$500

THIRD YEAR	
Total cost of machine at the beginning of third year	$11,600
Operating cost	1,100
Repairs	700
Losses due to lack of dependability	3,000
Total	$16,400
Probable value end of third year	$2,000
Total cost of use made of machine during first three years	$14,400
Average cost of use during first three years	4,800
Increase in cost of third year's use over first year's use	$2,500

Stating the cost of using equipment in this way brings out several facts. The first of these is that if the value that has been assigned to this hypothetical machine at the end of the first year can be obtained as a trade-in value, it will be more profitable to trade in at the end of the first year than to carry the machine longer. Actually it will be as well to trade in if the price offered on a trade-in is within $500 of the price set, as cost has mounted that much during the next year.

During the third year the losses due to falling dependability have mounted sharply. This machine was carried by the contractor as worth $3,500 at the end of the second year, but its falling dependability generated so much extra expense that the contractor would have saved money if he had traded it in at half of that figure.

By the end of the third year the losses occasioned by repairs and by falling dependability exceeded the remaining book value of this equipment, now $2,000. As all experience shows that these losses increase as equipment grows older, it is now perfectly certain that it will be cheaper to buy new equipment than to use the old equipment longer. In other words, the cost of repairs and of low dependability are now so high that even though the equipment and therefore the depreciation are given a zero value, the cost that this machine will generate will exceed the cost a new machine will generate if first cost less trade-in value is entirely written off in three years.

The use of this method of determining when to trade in equipment will require some change in customary practices in keeping equipment records, but in the long run contractors will find that the better knowledge of the cost of any lack of dependability and of functional inadequacy which the use of such a system involves will enable them to avoid the use of equipment that it is no longer profitable to have. The losses that poor equipment causes contractors are much larger than is commonly supposed. The answer is new equipment.

When to buy new

Finally, as to the equipment problem, the desirability of buying new equipment before the equipment now in use is worn out often presents itself. New designs offer greater capacity, a lower cost, an output of higher quality, greater dependability or perhaps other advantages. No set rule as to when old equipment should be laid aside before it is worn out can be given, but a few of the factors involved can be set down.

As to greater capacity, the first question to be raised is, "Can this greater capacity be used?" If a key unit is involved, the question to be confronted is the nature of the work ordinarily handled. A two-yard shovel, properly serviced, will produce more cheaply than a one-yard machine. Still, the difference is not very great, and if this lower cost is to be had, the hauling equipment must also be doubled. Will the work ordinarily obtainable justify this expansion? Will the capital structure justify it? A two-yard machine, to be a profitable investment, must have rather more than twice the work a one-yard machine will handle. Simply buying the larger machine will not improve the situation. Indeed, it will make it worse, for on the output that a one-yard machine can handle the cost of operating the larger machine will exceed the cost of operating the smaller machine. The problem which is involved in securing the larger machine is not, then, solely one of obtaining a lower unit cost. Rather it becomes a problem of securing the larger volume of work that the larger machine must have in order to produce the lower unit costs and of securing the larger capital required to finance this volume.

Where greater output capacity is offered in machines to be used on subsidiary operations, the problem is simply: Can the larger capacity be utilized? Quite often it cannot, and so is of no particular value—that is, not of enough value to justify a change before the equipment now in use is worn out. If the mixer can handle a batch of concrete only every 1½ minutes and the present batching plant can deliver a batch every minute, no gain can be had by discarding it to install a new batcher which will deliver a batch every ¾ of a minute. Subsidiary equipment must have a capacity as great as—preferably a little greater than—the key producer. But if it already has this capacity, additional capacity serves no useful purpose.

Lower cost, when presented as an incentive to purchase, is apt to be based

on greater capacity. It is very important always to bear in mind that when this lower cost is to be obtained through greater output, there must be reasonable prospect that the greater output can be secured. Otherwise the lower cost will not be had.

If, on the other hand, the lower cost is based on improvement in design and is obtainable on the same capacity that former models have had, it is of more immediate interest. Usually a reduced cost of this character is relatively small. In the nature of the case it cannot be otherwise. Depreciation, repairs and losses due to a lack of dependability tend to exceed operating cost, so any saving here is unlikely to warrant displacing equipment before it is worn out. However, cases have occurred where the savings offered at this point were large, and no doubt they will reoccur in the future.

Greater dependability is a factor of large moment. Machines so well built that they would function without repairs and with no lack of functional adequacy during their reasonable life would be invaluable. No such machines have ever been built, though it is only fair to observe that the dependability of contractor's equipment has improved steadily and rather rapidly during the past ten years. But when it comes to purchasing new equipment, though dependability is of inestimable value, it is not a thing which as yet can be demonstrated in advance. Therefore, claims that dependability has been improved offer no valid basis for laying aside equipment now in use until its normal usefulness evidently is past.

Modern Mechanical Layout for a Swimming Pool

New installation at Texas A.&M. College provides all facilities for furnishing filtered chlorinated water for a 60x100-ft. pool

By James M. Forsyth and J. A. Zeller
Superintendent of Mechanical Installations and Associate in Sanitary Research, Respectively; A. & M. College of Texas, College Station, Texas

Fig. 1—New pool at Texas A.&M. College. Tier seats accommodate 600 spectators.

IN THE DESIGN of the new swimming pool at the Agricultural and Mechanical College of Texas, every effort has been expended to promote economical and efficient operation. The pool itself is 60x100 ft. The depth varies from 3.5 to 10 ft., and total water content is 280,000 gal. The floor is of conventional white tile with black lane markers. The walls are a mixture shading from white at the bottom to blue at the water line. It is housed in a building 85x125 ft., including a gallery along the east side seating 600 persons. The pool is provided with a recirculation system, so designed that the water takes the following course: overflow from the pool, surge tank, surge-tank sump, pressure filters, heat exchanger, return to pool. The water is treated with alum, sulphuric acid (because of its high alkalinity) ammonia and chlorine.

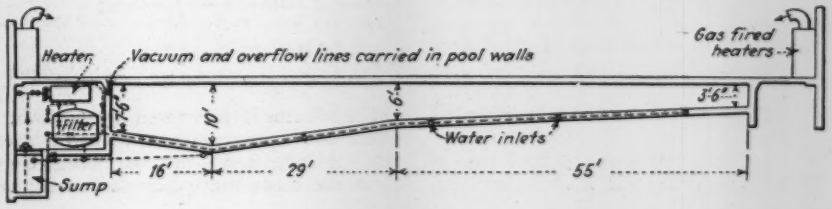
The building is heated by four thermostat-controlled gas-fired heaters provided with motor-driven blowers. Adjustable louvres permit any combination of fresh air from the outside with recirculated air from the inside. Six motor-driven ventilators exhaust vitiated air from the dressing rooms. Adequate toilet and shower facilities are provided, including a continuous-flow shower from sides and top and a chlorinated washing pool at the entrance to the pool. The layout is such that it is practically impossible for any one to enter the pool room without being thoroughly wetted.

Overflow from the recirculation system occurs around the entire periphery of the pool. Collected by two 5-in. pipes, the water finds its way by gravity to a 9,500-gal. surge tank whose purpose is to prevent loss of water by displacement and splash when a diver plunges. A float-controlled valve admits fresh water to the surge tank whenever the water level falls below a depth of 12 in. This valve is the only point at which fresh water can be admitted to the system, and this arrangement positively prevents unfiltered water from getting into the pool.

In one corner of the surge tank there is a sump, 48x36 in. in area and connected to the surge tank proper by a 6-in. float-controlled valve, which limits the maximum depth of water in the sump to 24 in. An overflow to waste is provided at a depth of 25 in. This maintains the water level in the sump below the level of the bottom of the chemical feed tank. All chemicals are fed by gravity into the sump.

Three 25-g.p.m. centrifugal pumps di-

Fig. 2—Longitudinal section of new pool at Texas A.&M. College.



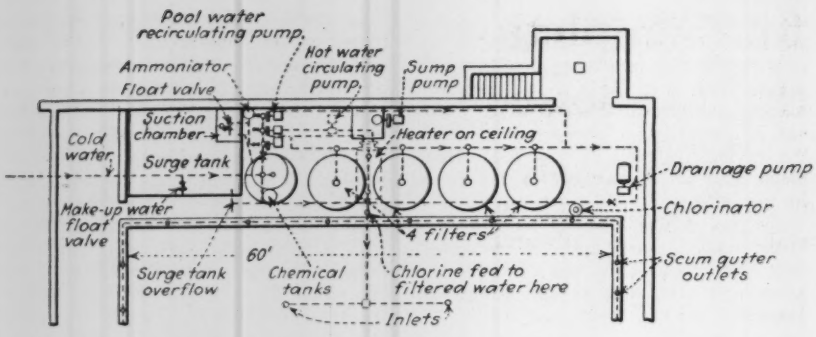


Fig. 3—Piping layout for recirculation of water of new pool, providing for chemical treatment, filtration, ammoniation, chlorination and heating.

rect-connected to 2-hp. electric motors are mounted directly in front of the sump and connected to a common header having a tap into the sump at each end. Each pump is supplied with valves, air-relief cock and hair catchers so that any pump or combination of pumps may be used to operate the filters. On the discharge side is a common 5-in. header which divides into two 5-in. headers passing all the way acros the filters.

The filters are four in number, each 84 in. in diameter. They are constructed of 3.8-in. boiler plate, with all-welded seams. The top of each filter is connected to one header by a 4-in. pipe with valve and venturi flow indicator. In this header is a 5-in. meter. The bottom of each filter is connected to the other header through a valve. Each filter is supplied with an individual loss-of-head gage. The latter header has a take-off between filters No. 3 and 4, returning to the pool.

The take-off leads to a heat exchanger for warming the pool water. A 30-g.p.m. pump takes water at 180 deg. F. from the shower water heater, circulates it through the exchanger and returns it to the heater at approximately 140 deg. F. The exchanger is of cast iron with copper tubes. A chlorinator is placed at the point where the take-off passes through the wall, and no water returns to the pool unchlorinated whether the heat exchanger is in operation or not.

Filtered and chlorinated water returns to the pool through ten points in the bottom, located at the corners of 20-ft. squares.

The chemical feed equipment comprises three tanks. One is for strong sulphuric acid, necessitated by the high alkalinity of the water. It is connected by lead pipe to a cylinder of acid outside the building. The second tank, of cypress staves, is for dissolving alum. The third is a feed tank, is lead-lined and discharges by gravity into the sump tank. An ammoniator also discharging into sump tank is set near the chemical tanks.

There are two ports in each side of the pool, submerged 12 in., with vacuum-cleaner connections. A 2½-in. line runs to a header over the circulating pumps and is provided with a vacuum gage and a separate valve to each pump suction ahead of the hair catcher. Thus, any or all of the circulating pumps may be used to operate the vacuum cleaner. On the discharge side of the pumps is a valved waste line permitting the soiled water to be wasted without passing through the filter headers.

One 1,100-g.p.m. pump connected to four ports at the bottom of the deepest point of the pool provides for emptying the tank.

All piping, fittings and valves are copper to resist corrosion. All steel parts, such as the filters and surge tank, are welded throughout. Copper tubing has been polished and lacquered to preserve its attractive finish. Steelwork has been aluminum bronzed on the outside and given asphalt paint on the inside to prevent rust.

Throughout the entire installation automatic devices have been used to make operation as simple and safe as is humanly possible. At the same time the particular characteristics of the water to be handled have received due consideration.

The pool was designed by F. E. Giesecke, college architect, assisted by his staff, of which the authors are members. It was built by W. A. Orth, superintendent of construction, at a cost of $75,000, and officially placed in operation April 13, 1933.

Nebraska NRA Road Program Is Going Ahead

Engineering News-Record Staff Report

IN VIEW of recent complaints from Nebraska charging failure of the NRA, the public-works program in general and the highway program in particular, it is interesting to learn by local check of the facts that commitment of the state's share of the $400,000,000 emergency appropriation for highway improvement has been reasonably rapid. The charges of delay in getting the relief-work program actively under way are disputed by the official records. Difficulties in respect to contracting for road work have been placed in a false light, as no considerable amount of main-road improvement has been undertaken by direct labor.

Official figures as of Oct. 19, obtained by personal interview at the state department of roads and irrigation and checked closely by the records of the district engineer of the U. S. Bureau of Public Roads, show these conditions:

Contracts let on state highways	$2,435,908
Contracts let on municipal highways	416,315
Contracts let on secondary highways	306,572
Total contracts let	$3,238,875
Estimated costs of secondary-road projects by direct labor	$686,000
Total amount committed	$3,924,875
Total allotment	$7,829,969
Remainder uncommitted	$3,905,084

Confidence is expressed by Roy L. Cochrane, state engineer, that the remaining $3,905,084 of the emergency fund will be committed by Jan. 1, 1934. Of the work designated as contracted, only four projects are being performed by direct labor. The $686,000 of direct-labor operations are confined to secondary roads and were undertaken in compliance with the desire of the Bureau of Public Roads to hasten employment and its recent ruling allowing work to be begun preceding submission and official approval of plans. The work is confined to secondary roads. The Department of Roads and Irrigation stated positively that no material change from contract to direct-labor construction is contemplated in the road work undertaken with PWA highway funds.

Early bids for PWA road projects showed a substantial increase over the prices current in 1932 and were rejected as too high and because of alleged indications of collusion. Local contractors' associations positively decry any collusion and assert that the higher bid prices merely reflected increased costs due to more severe state-road specifications, stronger materials markets and PWA requirements as to wages, hours of labor and hand work. They state, convinced by repeated rejection of bids on second advertisement, that reasonable prices could not be obtained, that contractors broke away from all cost estimates and bid in such a way as to secure contracts. This surrender to necessity is, contractors assert, the sole support of the claim that early bid prices were out of line with costs.

No Present Need for Completion of Dam No. 3 on the Tennessee

President's order requiring the Tennessee Valley Authority to undertake construction of the dam is out of line with the TVA program—More storage needed at the headwaters

By S. T. Henry
Southeastern Representative, Engineering News-Record, Spruce Pine, N. C.

ORDERS from President Roosevelt to the Tennessee Valley Authority Board to use part of its funds to build Dam No. 3 on the Tennessee River evidently were based on some other considerations than good engineering or sound economics. The project must be viewed essentially as a make-work undertaking.

Located at the head of slack water of the reservoir of Dam No. 2 at the Muscle Shoals project (Wilson Dam). Dam No. 3 originally was considered primarily as a navigation improvement. As laid out by the Corps of Engineers, U.S.A., it was to have created only a 39-ft. head. But early this year, after the contract had been let for locks adapted to that change in levels, the design was changed to permit the dam to be built high enough to develop a head of 56 ft.

In the order from the President to the TVA Board the announcement is made that this dam will be built primarily for power. Just how this can be reconciled with the local conditions remains to be explained. Nor does this policy line up with the recent statement of A. E. Morgan, chairman of the TVA Board, to the effect that the latter would not oppose the building of this dam with PWA funds, provided the TVA was not required to take over the carrying charges until the power thus created might be needed by the TVA at some indefinite future time.

Added to this situation, there is a question whether the height of the dam can be increased above that called for in the original designs without incurring property damages far beyond the value of the benefits of the greater height. This is due to the fact that the higher pond levels, including the necessary surcharge during floods, would drown out a considerable part of Decatur, Ala., an industrial town of local importance. Moreover, no accurate information has been made public, if it is available, on the great reduction in the natural flood-water storage in the stream and adjacent areas in the length of the Dam No. 3 reservoir that will occur if a high dam is built.

When it comes to navigation, no such investment as the $22,000,000 required to build Dam No. 3 can possibly be justified until the Tennessee is improved from the Ohio up to Wilson Dam, a distance of around 225 miles. To make such an improvement would involve far more than the total funds thus far appropriated to the TVA. Hence, the undertaking of Dam No. 3 must be based at present only on its value as a power project.

No deep study is needed to show that it is impossible at the present time to justify starting this project as a power producer. In the first place, this dam would have, as a power project, all the weaknesses of the Wilson Dam hydroelectric development. It would be subjected to the same lack of prime power in any considerable volume as occurs at Wilson Dam. Cove Creek storage is expected to correct this deficiency to a large extent. But it appears that all the estimates on the benefits to be derived from Cove Creek storage have been based on single years' records. Experienced operators of large hydro systems in the Southeast learned during the three-year low-water period of 1925, 1926 and 1927 that all previous estimates of available power from a stream, even with extensive regulation of flow, were far too high.

No reasons for the reduction in the height of the Cove Creek Dam have been made public in connection with the recent announcement of this change. Those who have followed the hydro experiences of 1925-1927 in that part of the country are certain, however, that at the end of three successive dry years similar to those of 1925, 1926 and 1927 far less water would be available from Cove Creek Reservoir that was stated as dependable in the driest year of record when the report on the project was made to the Congress. In other words, what is needed is not another huge run-of-river hydro project, such as Dam No. 3 will be, but more storage.

Such storage can be most economically created on any one of three important streams heading in Georgia and North Carolina, namely the Hiawasse, the Little Tennessee and the French Broad. In fact, those who know the records of these streams and something of the dam sites on them believe that for much less than Dam No. 3 will cost to complete as a power project, far more firm power might be created at Wilson Dam by providing headwater storage. To utilize this increased flow at Wilson Dam would require comparatively limited outlay then for mechanical equipment. The dam is complete, and the power house has space for more generators. Further, the headwater storage would be available to all future run-of-river projects that might be built later. It also would relieve the uncertainty of available water from Cove Creek at the end of a long dry period, since the runoff conditions on the three streams mentioned are far more favorable than those on the Clinch above the Cove Creek Dam site.

Letters to the Editor

Old Concrete Roads

Sir—In connection with F. H. Jackson's article, "Old Ohio Concrete Road Shows Record Service" (*ENR*, September 28, 1933, p. 378), I might state that we have several such old concrete roads in various sections of New York State which have rendered similar length of service. The thickness of the pavement varies between 5 and 6 in.; light steel reinforcement was used. While these pavements have longitudinal and transverse cracks the concrete is substantially sound, free of any disintegration. Some of these roads, which are still giving satisfactory service after nineteen years, were built in districts where the concrete pavements constructed within the last decade with the same concrete aggregates have been covered up or surface-treated because of weathering and disintegration.

The outstanding examples of excellent concrete are due to good workmanship and materials of satisfactory quality. However, I believe the term "satisfactory quality" is a very broad one. Some of the concrete aggregates used in New York State concrete pavements constructed in 1914-15, which have rendered such excellent service, are not being used at the present time because of their inferior quality, as measured by our present standard accepted laboratory methods of test. Yet these questionable or poor aggregates did give us satisfactory service in concrete for almost two decades, but have all of a sudden "gone bad."

It seems to me that the quality of the most important constituent in concrete has been completely ignored—namely, the cement. The latter subject I have fully discussed (*ENR*, Feb. 16, 1933, p. 212, and July 27, 1933, p. 112).

IRA PAUL,
Associate Laboratory Engineer, State Dept. of Public Works.

Albany, N. Y.
Oct. 4, 1933.

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EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, W. G. Bowman, F. W. Herring, C. S. Hill, H. W. Richardson, W. W. De Berard, N. A. Bowers, J. I. Ballard.

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The PWA's Opportunity

WHAT can be done to maintain employment during the winter hinges to a large extent on definite action by the PWA authorities in Washington to require winter construction. Road work will go on wherever possible, we have already been assured, but as to municipal projects the PWA has failed up to now to give any assurance that it will use its powers to insist on steady continuance of work. It has declared only that it will hold contractors to completion dates. This is by no means enough to meet the exigencies of the times. Clauses requiring due progress, or the maintenance of working forces of specified size, are well-established provisions of construction contracts, and the PWA has ample power to demand the inclusion of such clauses and to enforce their observance. In doing so it would work no hardship, for the contractor would take account of the special requirement in his cost estimates. Were he left subject to none beyond a time-of-completion requirement, on the other hand, he would inevitably be led to curtail or discontinue operations in cold weather, counting on making up the lost time in the spring. The serious effect of such procedure on employment is too apparent to need any emphasis. Inasmuch as the individual contractor cannot act constructively in the matter so long as his competitors are free to follow another course, it is the duty of the PWA to impose such requirements on construction work under its auspices as will assure the maximum degree of maintained winter employment.

For Quick Action on Housing

THE federal government has gone into the housing business with the express purpose of replacing city slums with modern low-cost living quarters. According to the announcement made on Oct. 28, operations will be carried on by a federal corporation in some 20 cities, using $200,000,000 of PWA funds. Predicated on the failure of private limited-dividend corporations to get projects under way fast enough, the new corporation has its main task plainly staked out—to increase the speed with which housing jobs are being provided. And this must be done in the face of an almost certain slowing up of private housing projects. On the other hand, the federal corporation's plans include definite help for states and municipalities in setting up local housing authorities whose activities may be made to supplement or at least to help the federal program; such recognition of the essentially local character of the housing problem is vital, as was pointed out in these pages last week. It may be that the total of these positive and negative factors will give a positive result. The best assurance that it will do so lies in quick planning and quick spending. There is no occasion for earmarking large sums of PWA money for a three- or four-year housing program. Too much of such earmarking has already taken its toll from the public-works fund. The only excuse for federal housing aid at the present time lies in the jobs it will create and the business stimulation that it will provide this year and next. The future can be left to local public housing authorities. The present demands on the federal government are solely for quick action in putting men and money to work.

A Retreat From Civilization

ILL-ADVISED effort at public economy, which for several years has prevented the sanitary improvement of countless communities, and which now greatly handicaps the national recovery program, is threatening the operation of existing facilities. In Schenectady, N. Y., a responsible local organization is exerting pressure to have the operation of the sewage-treatment plant discontinued on the score that it represents an item of expense that can be eliminated without apparent hardship to the community. Speciously, the argument runs that sewage treatment in Schenectady is unnecessary because the Mohawk River, into which the plant effluent is discharged, is already polluted beyond remedy by numerous other towns that make no effort at sewage treatment. But this schoolboy attitude is unworthy of an enlightened community; if the river is abused by the other towns, an effort should be exerted to induce them to institute remedial measures. Deliberately to bring about further river pollution would be a retreat from civilization.

Treated Sewage as Boiler Feed

THE ARRANGEMENT between the city of Herington, Kan., and the Rock Island Railroad, whereby the railroad is to purchase and use for boiler feed the effluent from a new sewage-treatment plant, recalls the discussion that appeared in these pages some months ago regarding the re-use of public water supplies in the arid regions of the West. In that earlier discussion the reason for putting a high value on sewage-plant effluent was scarcity of *water;* in the case of Herington, the treated sewage becomes of value because of the scarcity of *soft water.* By using the treated sewage in place of its accustomed supply the railroad is saved enough in softening costs to make the sewage plant a self-supporting enterprise. Human sensibilities may always find repugnant the idea of consuming the same water supply more than once, but with a locomotive squeamishness is not a factor and relative cost is the only thing that counts.

Grade-Separation Advance

THE concrete rigid-frame bridge in the south approach to the new Cincinnati union railway terminal marks, in this country at least, the extension of this type of bridge to railway service. In the past ten years municipal, state and county highway departments have embraced the short-span rigid-frame bridge extensively. Railway engineers have been slower to accept its merits except for highway use where they have cooperated in grade-separation overcrossings. But for railroad loadings the rigid-frame bridge, with its slender lines, has apparently been considered to be too radical a change from the massive proportions of orthodox railway struc-

tures. Now that the engineers of the Cincinnati Union Terminal Co. have broken away from tradition, it may be that the rigid-frame bridge will be looked upon more favorably. The design problems are no more intricate than for highway bridges. Construction difficulties may be somewhat increased because of the greater massing of reinforcing rods required by the heavier loadings. But the advantages of maximum underclearance, minimum approach grades, rigidity from continuity and economy in foundation excavation and abutment volume are the same whether the bridge is in highway or railway service. The Gest Street bridge provides railway engineers with an actual example of the new type of structure. To that extent it is a significant advance in grade-separation practice.

Pump Research

INCREASED knowledge of pumping equipment and pump efficiencies may be expected to result from the extensive program of research that is to be undertaken by the Metropolitan Water District of Southern California as a preliminary to the design of the pumping plants that will form an important part of the Colorado River aqueduct system. The problem of lifting 1,500 sec.-ft. of water over a 1,600-ft. summit warrants comprehensive study of the pumping machinery. Estimates that a saving of one per cent in efficiency will produce an annual saving of $41,000 in power costs indicate the dividend that can be paid on this research. The present instance is another case in which the size of the problems connected with the Boulder Dam project has made feasible an investigation otherwise uneconomic. Again the research laboratory will be made to produce direct results for the practical engineering problem. In addition to providing valuable information for the design of the aqueduct pumping equipment, the program should result in a definite advancement of knowledge of large pumping units.

Out of Harmony

IMMEDIATE construction of Dam No. 3 on the Tennessee River, as ordered by President Roosevelt, can be justified on no ground except that of political expediency. Its entire lack of harmony with the Tennessee Valley Authority's plan, or with any logical plan for development of the valley, is outlined elsewhere in this issue. The Tennessee Valley Authority was set up to plan broadly for the coordinated development of the natural resources of the region and to prosecute the plan. To be justifiable, such planning had to call for the construction of every element of the power and navigation systems in such sequence that each facility would become productive of return upon the investment at the earliest possible time. If approached otherwise, vast sums of money would be tied up in unproductive projects. The TVA has recognized that requirement and to date has planned to make its undertaking self-supporting as soon as possible. Consequently when construction of Dam No. 3 was proposed, it expressed its disapproval on the ground that the dam was needed neither for power nor for navigation. For this stand it is to be strongly commended. Equally strong condemnation rests on the politicians in the Tennessee Valley who by their importunity forced the President to overrule the men set up by him to plan and direct the valley's development.

Employee Representation

COLLECTIVE bargaining between employers and employees is provided for in the pending engineers' code as in all codes drawn up under the Recovery Act. The code also provides that within four months after its adoption minimum wage rates approximating those of 1929 shall be set for the several states or for larger regions. While these rates do not have to be established through collective bargaining between employers and employees, it is obvious that if they are not acceptable to a considerable number of employees, resort will be had to the collective-bargaining provisions of the code. Hence it is logical to expect that they should be so established wherever possible. This consideration, therefore, raises the question as to what organizations are truly representative of both employer and employee. Because it is the more urgent, the question of employee representation calls for first consideration.

The problem of employee representation in a profession like engineering is a difficult one. In architecture, where the profession is smaller and more closely knit together, the American Institute of Architects, under the architects' code, has undertaken to organize the subprofessional group. When a like proposal was made recently to the board of direction of the American Society of Civil Engineers, it turned it down, temporarily at least. The board has, however, undertaken to study the problem, and wisely so, since in large part the society itself is made up of employees of diverse classifications.

It is conceivable that the society might set up a system under which the major classes of employees could be able to express their views collectively on compensation and related employment conditions. But men in the same classes outside the society still would be unrepresented, and in many regions these men might constitute a majority of their class. Further, the men classified under the engineers' code as "engineering assistants" would not be provided for, since they are ineligible for membership in the society. These considerations indicate that a truly representative organization or organizations should be built up outside the society even though affiliated with it.

For men classified as engineers under the code there is reason to believe that they can best be represented by local organizations such as the New York State Society of Professional Engineers, organizations whose basic qualification for membership is registration as an engineer by the state. Such organizations are and by nature always will be more representative of the profession engaged in engineering construction than is the American Society of Civil Engineers, and in addition they take in mechanical and electrical engineers. Local organizations of engineering assistants, affiliated with these state bodies, also appear to provide the simplest means for obtaining representation in wage discussions for the several groups of men so classified.

Viewed from any side, the matter of establishing equitable wage rates appears to be a local task. Its national aspects are chiefly those of maintaining the maximum amount of uniformity, and that can be obtained through the national control committee to be set up under the engineers' code. But the details of even local organizations are going to be difficult to work out. They constitute a problem to which all elements of the profession should give immediate and serious consideration.

NEWS OF THE WEEK

Use of PWA Funds For Relief Approved By the President

ALLOTMENT of funds by the Public Works Administration for work relief has been approved by President Roosevelt as a means of converting federal funds appropriated for direct relief from a dole into a wage. The relief funds distributed among the states can be used to employ men on relief rolls but such work has been lacking because no part of the federal money may be spent for supervisory expenses, equipment or materials. By combining PWA with direct relief funds these items are covered and work programs can be laid out. PWA's contribution to such projects is 30 per cent of the total.

The Public Works Administration does not regard this plan as conflicting with its policy of carrying forward construction of public works on a contract basis because the character of work proposed does not justify the administrative cost involved in contract construction.

Survey work financed

PWA allotments for relief work include $2,500,000 for equipment and materials needed in malaria and other disease control work to be supervised by the Public Health Service. The Federal Emergency Relief Administration will pay the labor employed. The Coast & Geodetic Survey has been alloted $563,120 for surveying operations. The Relief Administration will put up $3,525,000 for labor. This project won the endorsement of the administrative board of American Engineering Council because of the opportunities afforded for employing idle engineers on relief rolls, although the maximum that will be paid is $15 a week.

Relief road work

Allotments amounting to $4,461,000 have been made to 7 states as part of a $14,870,000 total for road building. The balance will be contributed by the Relief Administration. This is the nearest approach that the relief work program makes to the public works program proper but as 70 per cent of the total will be paid out to men on relief rolls the work will necessarily be of a simple character. Grading and surfacing with local materials is the probable extent of such projects.

No fixed wage scale

The men will work for allowances that will meet the needs of their families rather than for a fixed wage. All projects will be supervised by the state highway departments in conformity with regulations now being drafted by the Bureau of Public Roads. It is expected that in some cases the 30 per cent contribution by PWA will not cover tools and materials, so additional funds must be obtained from other sources. The work relief program assumes that local relief funds will be drawn upon if available. The road work will be done in 182 drought-stricken counties as follows: Colorado 3, Kansas 18, New Mexico 6, North Dakota 49, Oklahoma 7, South Dakota 64, and Wisconsin 35.

Inasmuch as the money distributed among men drawn from relief rolls for these work programs does not actually represent a wage and may vary considerably with local conditions and personal requirements, the allotment of funds for this purpose by PWA nullifies its previous policy that the PWA wage scale must be paid on all projects financed wholly or in part with public works funds.

Low Bidder Enjoins Award To Second Low Under NRA

Award of the contract for the post office annex at New York to the second low bidder was enjoined in Washington on Oct. 30 by the low bidder, the George F. Driscoll Co. of Brooklyn. The federal government proposed to award the contract to the second low bidder because the Driscoll company had not signed the President's reemployment agreement or an NRA code at the time it bid. The case will be heard Nov. 3.

Original bids on the post office annex were taken in February; in September the Treasury Department asked for additional bids. For the latter, the specifications required that the bidder be under the NRA. The George F. Driscoll Company's bid of $4,248,800 was $112,800 lower than the second bid but award was protested on the ground that the company was not under the NRA. Subsequently the company signed up.

Plan to Shift Charles River Course in Old Cambridge

A plan to shift the course of the Charles River for about three-fourths of a mile in Cambridge and Brighton, Mass., has been prepared by the Metropolitan District Planning Commission at Boston, Mass. With an estimated outlay of about $700,000, it is intended to swing the channel of the river eastward toward Soldiers Field and the Harvard Stadium; to build a bridge across the river at Gerry's Landing, near the Cambridge Hospital; construct two traffic circles at the ends of the bridge and build two overpasses for foot traffic from Mt. Auburn St., Cambridge, to the parkway reservation bordering the stream. The project provides for the elimination of certain dangerous curves existing on roadways in the vicinity of Soldiers Field and for a faster motor route from the Boston side of the river through Old Cambridge and Fresh Pond Parkway to connect with the newly authorized Cambridge-Concord turnpike. Relief of traffic congestion at Harvard Square would also be a feature, in view of the anticipated increase in vehicular movement to result from the completion of the new turnpike.

Low Cost Housing Company Formed To Assist PWA

A COMPANY to be known as the Public Works Emergency Housing Corporation was incorporated by the federal government on Oct. 28. Planned to act as an executive arm of the PWA, its purposes as set forth in the articles of incorporation, are "to construct, reconstruct, alter or repair low cost housing projects or slum clearance projects, apartment houses, homes and structures of every nature." According to the PWA announcement the corporation will engage in low-cost housing and slum clearance projects which otherwise would not be undertaken. It also will lend every assistance to states, municipalities and public housing authorities and "it may finance projects outright as a demonstration to the country of what can be done."

Broad powers granted

The corporation has power to acquire property by purchase or by exercise of the right of eminent domain. It has broad powers to engage in a general construction business, to finance and aid in financing low-cost housing and slum clearance, to perform engineering and architectural work and to conduct and carry on the business of builders and contractors. In addition the corporation has power to construct and maintain roads, avenues, parks, playgrounds, recreational facilities, sewers, bridges, walls, utilities and incidental improvements in connection with housing projects. The corporation also may equip, furnish, operate, manage and maintain homes and buildings of every nature.

In connection with the formation of the corporation Harold L. Ickes, administrator of public works, said "Through this corporation we hope to speed construction in localities where private enterprises or public bodies are encountering serious difficulties due to legal restrictions and other obstacles. Our experience of the last three months indicates clearly that we may not depend upon private enterprise or limited-dividend corporations to initiate comprehensive low-cost housing and slum clearance projects." Mr. Ickes stated that Robert D. Kohn, director of the PWA housing division will, during the next few months, make a personal survey to promote "better understanding of the serious nature of housing conditions in some 20 cities."

Local housing authorities

The efforts of the corporation will be directed toward encouraging the creation of local public housing authorities. Where the municipality lacks or cannot immediately obtain the necessary charter powers it is proposed to proceed along one or the other of the following courses:

(1) To foster local group study of available low-cost slum land, with acquisition by private contract if possible, otherwise by

eminent domain, which power is derived from the Recovery Act.

(2) To assist state legislatures in creating housing authorities in cities or counties so that such authorities may cooperate with the federal government, or may act as its agent in the management of the properties when completed.

(3) To develop a procedure which will aid a city to work out a long-term plan on which to continue the process which the federal government starts. Eventually each state or large metropolitan area would have an agency empowered to engage in the rehabilitation of low-cost residence areas. Through such a body the federal government could continue its help and eventually, in a lesser and lesser degree, aid what must become a local function of government.

Mr. Ickes emphasized the need for acquiring land at an unusually low price. The housing projects will not be standardized, but only low-type structures will be permitted. The amount of funds to be transferred to the new corporation will be determined by the PWA as developments require.

Sale of Chicago Drainage Canal To Federal Government Proposed

The finance committee of the board of trustees of the Chicago Sanitary District has instructed its attorney to prepare the draft of a bill to be submitted to Congress calling for the sale of the Sanitary District Canal and the Calumet-Sag Channel to the federal government. Proceeds of the sale will be used for further construction work by the district. The board also instructed its chief engineer, Philip Harrington, to determine the cost of appraisal of the value of the new channel.

Several Cities in Indiana Ordered to End Stream Pollution

In a drive to stop the pollution of streams in Indiana, the state board of health has ordered five cities to undertake the construction of sewage disposal plants forthwith. The total cost of the work ordered will amount to over $7,000,000 and is distributed as follows: Fort Wayne, $5,000,000; East Chicago, $500,000; Michigan City, $500,000; Hartford City, $65,000 and Muncie, $1,000,000. The board of health is holding conferences with other communities in the state and it is expected that further work of this character will be required in the future.

Sewer District Organized For St. Paul and Minneapolis

The district commission for the metropolitan sewage district of St. Paul and Minneapolis held its organization meeting on October 30. The time in which taxpayers could protest against the formation of the commission expired on October 30. On August 22 the state board of health declared a joint sewage disposal system a public necessity and subsequently the city councils of each city named three members each, and a seventh, member required by law to be from outside the district, was appointed by the governor. One of the first acts of the commission will be the appointment of a chief engineer.

Construction Code Held Up Indefinitely By Labor Opposition

FINAL ACTION by the National Industrial Recovery Administration on the basic code for the construction industry, and on some of the supplemental codes, which was hoped for last week, has been postponed indefinitely on account of the strong opposition of organized labor to the wage and hour provisions of the code, and to the constitution of the national control committee. The Building Trades Division of the American Federation of Labor is opposed to the rate for unskilled labor of 40 cents an hour, and to the maximum average of 40 hours a week during a six-month calendar period, or 48 hours in any week in such periods now in the code. It would write in the minimum rates established by the Public Works Administration, and would include a maximum 30-hour week with high rates for overtime. It also proposes that labor have equal representation with the organization sponsoring the code on the national control committee.

Strong opposition also is expressed to the so-called step-up plan of the Deputy Administrator Malcolm Pirnie whereby the rates 20 per cent lower than the rates now proposed for the construction industry code, but not lower than present rate, be continued for a year. Thereafter all rates would be increased by a definite amount. By this plan it is hoped to stimulate private construction.

No provision has been made for writing this step-up plan into the code, but the labor organizations are opposing it strongly, for fear that it may be adopted.

Meetings between Deputies Muir and Pirnie, the lawyers of the NRA, and its labor advisers, begun last week, has continued into this week, and are expected to continue throughout the week.

John Fritz Medal Awarded To J. R. Freeman, Posthumously

The John Fritz Medal board of award has announced that the John Fritz Gold Medal, the highest of American engineering honors, has been awarded to the late John R. Freeman, Providence, R. I., as an "engineer pre-eminent in the field of hydraulics and water supply, fire insurance economics, and analysis of earthquakes." According to the board's announcement, the award was made posthumously because of the sudden death of Mr. Freeman on Oct. 6, 1932, during the procedure for his selection as a medallist. The board consists of the 16 recent past-presidents of the four national engineering societies representing civil, mining, metallurgical, mechanical and electrical engineers.

Joint Sewerage Works Described At New York Sewage Association

THE varied aspects of joint sewerage facilities for adjacent communities occupied the leading position in the discussions before the New York State Sewage Works Association, which met at White Plains, N. Y., on Oct. 27 and 28. Two important examples of such joint facilities were described in detail, the works of the Joint Meeting in Essex Co., New Jersey, and those of the Westchester County Sanitary Commission, in New York. Considerable attention at the session was also given to the developments in chemical treatment of sewage at Freeport, Long Island.

The joint sewage works in Essex County, N. J., serving Elizabeth, Rahway and other communities, were described in a comprehesive paper by Alexander Potter, New York City. These works include joint trunk sewers and a joint treatment plant. A total tributary area of 50 sq.mi. is served, with the costs apportioned between the communities on the basis of the capacity provided for each in the entire project. Rapid increase of population has required within the last few years the construction of a supplementary trunk sewer, and a treatment plant at south Elizabeth.

The building of the supplementary trunk sewer involved a number of difficult construction problems, particularly those occasioned by necessity of crossing under a number of heavily traveled railroad lines. In most of these cases steel liner plates were used in the tunnelling, with grout placed between the liner and the railroad fill before the pipe was placed. Reinforced-concrete pipe was used, which in the tunnels was skidded into place on rails set to proper line and grade on the tunnel floor. After the pipe was placed the space between the tunnel plates and the pipe was filled with grout.

Treatment at the south Elizabeth plant comprises screening, grit removal, sedimentation and chlorination. Sludge is to be dumped at sea. The plant is now completed with the exception of sludge-storage tanks and about 450 ft. of discharge line, the construction of which has been held up by lack of funds. Sludge disposal will call for barges with a capacity of 300 tons, which are to dump sludge at sea at two-week intervals, and a sludge-storage capacity of three weeks' accumulation.

An entire afternoon was given over to a description of the sewerage facilities constructed and operated by the Westchester County Sanitary Commission. The different phases of the work were described by members of the engineering staff of the commission, including W. W. Young, consulting engineer, F. J. Laverty, F. C. Zeigler, E. C. Hallock, J. W. Van Denburg and W. R. Schreiner.

The present legal authority of the sanitary commission dates from 1926 when the state legislature authorized the board of county supervisors to establish sanitary districts and to design, construct and operate the necessary sanitary facilities, assessing the costs among the various municipalities in proportion to their assessed valuations. At the present time nine sanitary districts have been created, with nine trunk sewer branches totalling 80 miles in length. These nine districts represent 30 per cent of the area of the county, but include 66 per cent of the present population and 65 per cent of the assessed valuation. There are four screen-

ing plants in operation. The districts now virtually completed are designated as the Bronx Valley, Blind Brook, Mamaroneck, Hutchinson Valley, South Yonkers, Sawmill, North Yonkers, Upper Bronx Valley, and Central Yonkers districts.

Screening and chlorination plants have been provided for the Mamaroneck, Blind Brook and South Yonkers Projects, the last of which also serves the Bronx Valley, Upper Bronx Valley and Hutchinson Valley districts, and for the North Yonkers project, which also serves the Sawmill and Central Yonkers districts. Treatment at each of these plants comprises coarse screening, grit removal, fine screening and chlorination. Regular observations are made on the dissolved-oxygen content of the waters of Long Island Sound and the Hudson River at the points of sewage discharge. There is apparently a slight tendency of the summer minimums to rise from year to year.

For the past several years plant-scale experiments have been conducted at Freeport, L. I., on the applicability of chemical precipitation to the local sewage treatment problem. It has been found that ferric chloride will greatly aid sewage sedimentation, and that time of mixing is an important factor. Further, it has been noted that thorough mixing for 15 minutes will improve settling even if no chemicals are added. High-speed mixing was found to be no better than more gentle agitation.

Engineering Council Opposes Federal Utility Competition

The Public Works Administration is urged by resolution of the administrative board of American Engineering Council to declare, as sound public policy, that it will not finance municipal water and electric plants to compete with privately owned companies that are rendering adequate service under public regulation.

The board commended the cooperative arrangement by which the Public Works Administration has allotted $563,120 to the Coast and Geodetic Survey to supplement $3,525,000 provided by the Federal Emergency Relief Administration.

Council's administrative board regards this plan as a desirable method of creating employment for many idle engineers now on relief rolls. The work to be undertaken will supplement the regular control surveys program by establishing additional points tied into the 25-mile spacing of arcs of triangulation and lines of leveling so that ultimately the federal net will be brought within reach of any engineering project to which it might be of value.

State relief administrators have been authorized by Harry L. Hopkins, federal relief administrator to pay up to $15 a week to technically trained men on relief rolls for this work. State engineering unemployment committees will be requested by American Engineering Council to cooperate with state relief agencies and the state units of the Geodetic Survey.

The administrative board's pledge of cooperation does not imply that Council will support the application of this method of work relief to projects ordinarily executed by contract.

The assembly will meet in Washington Jan. 11-13. William McClellan, president of Potomac Electric Power Co., Washington, was elected treasurer of Council to fill the unexpired term of the late Farley Osgood.

Municipal Projects In Large Number Get PWA Loans

SEVENTY-FIVE non-federal loans and grants totaling over $7,000,000 were approved by the Public Works Board during the week ending Oct. 28. Details are given in an accompanying table. The list is notable for the large number of direct grants thus insuring little delay due to the legal difficulties connected with loan approvals. A combined loan and grant of $3,500,000 to Denver, Col., for additional water supply through the Moffat Tunnel pioneer bore, is of interest because the loan is secured by transfer of the title to real estate and other property to the federal government. The water commissioners will lease the property.

In connection with an allotment of $1,500,000 to the state of Georgia for the construction of a state prison in Tatnall County the PWA, for the first time, had resort to the provisions of the Recovery Act that permits the federal government to build non-federal projects and lease them to the ultimate owner until paid for. The land will cost $300,000 and the buildings $1,200,000. The state cannot borrow the money under its constitution.

Two housing loans

Two additional allotments for housing work have been made by the PWA, $1,900,000 to the Lane Gardens Corp., Cincinnati, Ohio, a limited-dividend corporation, for a group of 3-story and 4-story walk-up, fireproof apartment buildings to rent at about $9 a room. The building will occupy 27 per cent of a 10 acre plot. The total cost is estimated at $2,380,000. The Sunshine Apartment Corp., also a limited-dividend body, was allotted $663,000

DETAILS OF PWA LOANS AND GRANTS FOR NON-FEDERAL WORK

Location	Loan & Grant or Grant	Type	Man-Months Work Provided	Amount
Brainard, Neb.	L. & G.	Sewage system	108	$22,000
Cotter, Ark.	L. & G.	Waterworks system	123	55,000
Georgetown, Ill.	L. & G.	Waterworks	540	140,000
Manchester, N. H.	G.	Reservoir	900	61,000
(Substituted for combined loan and grant of $250,000 made previously)				
Bannock County, Idaho	L. & G.	School	75	42,600
Albion, Ind.	L. & G.	Water	120	32,000
Anne Arundel Co., Md.	L. & G.	Sewage disposal	300	62,000
Bristol, R. I.	L. & G.	Sewage	800	200,000
Grand Junction, Col.	L. & G.	Water	400	100,000
Mountain Grove, Mo.	L. & G.	School	216	69,157
Spearfish, S. D.	L. & G.	Dam	350	64,280
Kansas City, Kan.	G.	Waterworks improv.	462	29,000
Pratt County, Kan.	G.	Roads	125	3,900
Belgium, Wis.	G.	Sewage	180	2,000
Pratt Co., Kan.	G.	Roads	100	4,000
Pratt Co., Kan.	G.	Roads	100	4,300
Pratt Co., Kan.	G.	Roads	160	6,500
Bethel, Kan.	G.	School	45	2,200
Montpelier, Vt.	G.	Sewer	50	900
Kasson, Minn.	G.	Water supply	5	300
Wilkins Co., Minn.	G.	School	456	53,100
Austin, Minn.	G.	Building	105	9,000
Pueblo, Col.	G.	Dormitories	1,320	92,000
Jefferson County, Kan.	L. & G.	Roads	560	82,000
Ogden, Utah	L. & G.	Waterworks	6,750	750,000
Tippecanoe Co., Ind.	L. & G.	School building	38	15,000
Jefferson Co., Kan.	L. & G.	Roads	1,120	84,000
Shelby, Ohio	L. & G.	Building	600	160,000
Lena, Ill.	L. & G.	School building	360	50,360
Pembine, Wis.	L. & G.	School building	125	35,000
Vineland, N. J.	L. & G.	Waterworks	100	35,000
Hartsville, S. C.	L. & G.	Waterworks	625	73,000
McPherson, Kan.	G.	Water	180	12,000
Bridgeville, Del.	G.	Sidewalks	30	800
State of Ill.	G.	Hospital	224	17,500
State of Ill.	G.	School	150	14,445
Paxton, Mass.	L. & G.	Water supply	255	85,000
Carrollton, Ky.	L. & G.	School	30	12,000
Blue Earth, Minn.	G.	Power house	204	25,000
Harris Co., Texas	L. & G.	Highway	220	36,945
Rapid City, S. D.	L. & G.	Sewer	840	180,000
Sheboygan, Wis.	L. & G.	School building	1,140	307,630
Harris County, Texas	L. & G.	Roads	80	172,475
Williamsport, Md.	L. & G.	Sewage plant	150	88,000
Denver, Col.	L. & G.	Waterworks	20,250	3,500,000
Dodge Co., Neb.	G.	Paving	60	3,200
Aurora, Neb.	G.	Paving	145	6,800
Kingman, Kan.	G.	Hospital	120	4,000
Orrick, Mo.	G.	Paving	30	1,800
Sanborn Co., S. D.	G.	School	90	6,600
East Cleveland, Ohio	G.	Paving	82	7,500
East Cleveland, Ohio	G.	Sewer	108	7,200
Pratt Co., Kan.	G.	Paving	75	2,900
Hutchinson, Minn.	G.	Sewage plant	260	18,000
Codington Co., S. D.	G.	School	10	900
Barre, Vt.	G.	Paving	250	8,200
Richland Co., S. C.	G.	School	40	2,700
Moscow, Idaho	G.	Waterworks	45	4,000
Merrimack, N. H.	G.	Water system	69	6,000
Delhi, Iowa	G.	Waterworks	120	4,500
Brookline, Mass.	G.	Sewer	200	3,600
Muscatine Co., Iowa	G.	Highway	111	10,900
Ottumwa, Iowa	G.	Sewage disposal	52	2,000
Muscatine, Iowa	G.	School	40	4,800
West Union, Iowa	G.	Waterworks	36	3,300
Des Moines, Iowa	G.	Highways	292	10,500
Hudson, Iowa	G.	Water mains	7	500
Laurens, Iowa	G.	Sewage plant	45	2,100
Des Moines, Iowa	G.	Paving	75	5,000
Johnson Co., Iowa	G.	Paving	544	31,000
Harrisburg, Pa.	G.	Sewers	175	7,000
Pittsylvania, Va.	G.	School	455	42,400
Montgomery Co., Md.	G.	School	2,720	160,000
Des Moines, Iowa	G.	Building	7	500
Des Moines, Iowa	G.	Paving	43	3,200
		Total	47,377	$7,162,492

for a group of 2-story, non-fireproof apartment buildings in Richmond, Va., estimated to cost $780,000. Rents will average $5.50 per room per month.

Numerous allotments for federal work were made during the week. They include $1,350,000 for a Veterans' Bureau Hospital at Roanoke, Va.; $138,164 for construction at Camp Ripley, Minn.; $37,000 for post office work at Cambridge, Mass.; $19,000 for the State Dept. Building, Washington; $16,500 for additional work on preservation of the ruins in Mesa Verde National Park, Colo.; and $250,000 for roads and trails in Alaska.

Grand Coulee Dam

An advance of $1,000,000 has been made to the state of Washington for excavation of the foundations of the Grand Coulee Dam on the Columbia River.

The $15,000,000 recently allocated to the Army and Navy for aviation construction is to be divided evenly rather than as indicated in the announcement of last week.

All-American Canal

The allotment of $6,000,000 for the All-American Canal to the Imperial Valley in California, noted briefly last week, is to permit start of construction on a project costing $27,000,000, not including power features. Work is to be done by the Bureau of Reclamation.

The canal will leave the Colorado River at a point above Yuma, Ariz. and will extend westward 130 miles into the Imperial Valley. It will supply water to 500,000 acres but will bring no new land under cultivation.

Large projects favored

Concentration on large projects is urged upon state advisory boards by Administrator Ickes to speed the public works program. Mr. Ickes stated Tuesday that little more time or work is involved in preparing and handling a $1,000,000 project than one costing only $100,000.

Aroused by reports that municipal power projects are being blocked or held back, Mr. Ickes has sent personal letters to the advisory boards of two states this week demanding that such projects receive prompt consideration. Missouri is one of the states on which Mr. Ickes directed his fire. "I think," said Mr. Ickes, "I have made my position clear. Power projects are on a preferred list."

Ex-service men on contract work

An opinion requested from Attorney General Cummings on the preference that shall be given to ex-service ment by contractors on public works projects states, in effect, that within the ranks of union labor preference should be given to veterans over others, but that a contractor does not have to go outside of union ranks to get veterans. "A union contractor must, of course, give the preference among union men to those union men who are ex-service men with dependents," said the Attorney General. "He is not required, however, to employ an ex-service man with dependents who is not a member of the union in preference to union men who are not ex-service men with dependents."

Robert D. Kohn, director of the housing division of PWA, left Washington Oct. 30 on an unannounced itinerary that will take him as far as the Pacific Coast. It is understood that he is canvassing areas in which the new federal housing corporation may undertake construction.

Meeting Discusses Construction of Low-Cost Housing

THE National Conference on Low-Cost Housing, held under the auspices of the Cleveland Engineering Society, Oct. 25-27, delved deeply into the details of construction and provided an opportunity to discuss the best practices in planning, designing, and constructing modern, low-cost housing costing not over $5,000 per unit. The opening session was devoted to planning, the second and third sessions to materials and construction, and the concluding two sessions to plumbing, heating, and electrical services, and to a consideration of building codes. Supplementing the sessions of the conference were many exhibits of building materials and equipment. Registration for the three days exceeded 400. Ernest J. Bohn, Cleveland councilman who served as chairman of the earlier conference on Slum Clearance (*ENR*, July 13, 1933, p. 58) opened the Low-Cost Housing meeting.

Costs and trends

A feature of the first session was the talk by Robert L. Davison, director of housing research of the John B. Pierce Foundation, New York City, on "General Design Consideration." By way of introduction he asserted that while a large potential demand for labor lies in the construction of low-cost housing, this construction will be throttled unless there is a substantial reduction in land values, in materials, costs and in wages in the construction trades. Our present problem, according to Mr. Davison, is to build houses for the middle third of our population, which according to studies by the Pierce Foundation should rent for $25 per month. Allowing five dollars per month for carrying charges on the land including taxes, street improvements, utilities, etc., there is left $20, a month available for the maintenance and carrying charges of the dwelling itself. Thus such a dwelling should not cost, including architect's fee, contractor's profit and all overhead, in excess of $2,000, per family. Budgeting the $2,000 into the various items which enter into the construction of the completed home, 25c. per sq.ft. is allowed for the exterior walls of a single-story building, 50c. per sq.ft., including columns, for the exterior walls of a completed multi-story dwelling, 15c. per sq.ft. for partitions, 50c. per sq.ft. for the floor, including ceiling, and $500 for all mechanical equipment, including electric wiring.

Henry Wright, architect, New York City, who shared the opening program with Mr. Davison, stressed the fact that improvement and cheapening of low-cost housing must be handled together. Costs must be reduced not simply by undertaking to substitute one sort of process or product for another but by eliminating some building operations and cutting down on the number of elements involved in the dwelling itself.

Materials of construction

Much of the low-cost housing of the future will be constructed in large part by the owner himself, using some of the spare time the "New Deal" will bring him, Lawrence Kocher, editor, *Architectural Record*, forecast. This owner will use wood where wood is handy; he will also learn how to use concrete and how to do his own plumbing. This, said Mr. Kocher, will remove at least one of the more

DETAILS OF PWA LOANS AND GRANTS FOR NON-FEDERAL WORK
(Supplement to table published Oct. 26, p. 516.)

Locality	Loan & Grant or Grant	Type	Man-Months Work Provided	Amount
Pocatello, Idaho	L. & G.	Water	780	$149,674
Pocatello, Idaho	L. & G.	Reservoir	1,200	187,000
Ann Arbor, Mich	L. & G.	Sewer	4,500	650,000
Ottumwa, Iowa	G.	Armory	525	42,000
Fond du Lac, Wis.	L. & G.	Sewage plant	3,360	434,700
Harrington, Del.	L. & G.	Sewer	875	125,000
Farnhurst, Del.	G.	Poor Farm	262	26,000
Carlisle, Penn.	L. & G.	Sewage	720	220,000
Tomah, Wis.	L. & G.	City Hall	175	48,700
Douglas Co., Wis.	L. & G.	Bridges	3,000	437,500
Mt. Rainier, Md.	L. & G.	Street work	200	33,000
Macon, Ga.	G.	Waterworks	420	36,000
Monson, Mass.	L. & G.	Storage building	300	112,000
Northampton, Mass.	L. & G.	Hospital	810	242,000
Bingham City, Utah	L. & G.	Court House	195	35,400
Sacramento, Calif.	L. & G.	Flood control	1,525	194,824
East Grant Forks, Minn.	G.	Waterworks	30	5,000
Seattle, Wash.	L. & G.	Bridge	540	111,160
Northampton, Mass.	L. & G.	Hospital	320	106,000
Lincoln, Neb.	L. & G.	Waterworks	800	216,000
Framingham, Mass.	L. & G.	Police barracks	480	218,520
Fremont, Neb.	G.	Street lighting	75	7,300
Aberdeen, S. D.	L. & G.	Waterworks	5,180	789,000
Framingham, Mass.	L. & G.	School	96	34,000
Amherst, Mass.	L. & G.	Terminal building	330	121,000
Natick, Mass.	L. & G.	Building	375	114,000
Waltham, Mass.	L. & G.	Electric cable system	27	12,000
Anderson, Ind.	L. & G.	Waterworks	765	209,000
Monson, Mass.	L. & G.	Sewer	200	65,000
Rutland, Vt.	G.	Sewer	900	31,000
Peoria, Ill.	G.	Fence	75	2,300
Rochester, Minn.	G.	Sewers	400	24,000
Cincinnati, Ohio	G.	Street improvement	2,610	62,000
Alexandria, Minn.	G.	Heating plant	200	21,000
Kansas City, Kan.	G.	Bridge approach	600	49,200
Oakland, Calif.	G.	Building	8	600
Cincinnati, Ohio	G.	Street improvement	50	1,300
Austin, Minn.	G.	Water supply	39	3,000
Bedford Co., Penn.	G.	School	100	7,000
Franklin, Penn.	G.	Waterworks	12	1,500
Snohomish Co., Wash.	G.	Street improvement	148	13,000
Mason City, Iowa	G.	Waterworks	148	13,000
Mansfield, Conn.	G.	School house	80	5,700
Glendale, Calif.	G.	Reservoir roof	400	27,000
		TOTAL	33,807	$5,243,378

serious barriers to providing low-cost housing—the item of labor amounting to about 25 per cent.

In a discussion of the use of cement and concrete, R. E. Copeland, housing engineer, Portland Cement Association, described and demonstrated a simple type of reinforced concrete floor construction consisting of factory-made, concrete joists framed on the bearing walls of the structure in much the same manner as wood joists, and then covered with a 2-in. reinforced concrete slab.

Clayton Grandy, speaking on behalf of Ralph Stoddard, secretary-manager of the Brick Manufacturers Association of America, emphasized the fact that better designing, and the elimination of non-essentials, could contribute more immediately to low-cost housing than could the use of possibly better building materials not yet sufficiently developed nor adequately tested. Frank P. Cartwright, research engineer, American Forest Products Industries, Inc., reported on the recent developments in the use of wood products. He pointed out that "building dry" avoids the introduction into the finished structure of several hundred gallons of water ordinarily used for mixing plaster. It is of little avail, he insisted, to specify and use dry lumber and millwork if the wood is to be subsequently soaked with water from an associated building material.

Specific applications of steels and porcelains in low-cost housing were presented and discussed by M. G. Clark, president, Insulated Steel Construction Co., Cleveland; C. A. Strand, president, Stran-Steel Corp., Detroit; George H. Burrows, Cleveland architect; P. E. Selby, president, Steel-Bilt Homes, Inc., Cleveland; Charles B. Rowley, Cleveland architect, and L. Brandt, Pittsburgh housing engineer. Contributing to the discussion, Galin F. Oman of Pettig and Oman, Columbus architects, pointed out that for the immediate future, since the important thing was to put men back to work, it would be best to apply common-sense design to the conventional materials rather than to spend too much time experimenting with new products. He predicted that the house of the future will not be an "all-metal, all-wood, all-concrete or all-masonry house; but all-American, involving a balanced combination of these materials."

Agreement Reached on Price on Large Orders for Steel Rails

Agreement on a price of $36.375 a long ton for railroad rails was reached on Oct. 30 between the President and representatives of the steel companies. Last week, in response to a request from Railroad Co-ordinator Eastman, the principal steel companies of the country reduced the price of rails from $40 a ton to $37.75. Subsequently Mr. Eastman charged that there had been collusion between the steel companies in setting this uniform price and he offered them the alternative of cutting the price to $35 a ton, or opening their books to government accountants for a determination of the fair price.

Obituary

CHARLES F. ABBOTT, executive director of the American Institute of Steel Construction since 1923, died at New York on Oct. 27, age 67 years.

WALTER BUTLER, chairman of the Board of Butler Bros., contractors, Rochester, Minn., died there on Oct. 28, age 75 years. Mr. Butler has been prominent in contracting work in the Middle West for many years.

HARRY R. WHEELER, for 25 years an engineer for Henry Steers Sand & Gravel Co., died at his home in Northport, L. I., on Oct. 29, after a long illness. Mr. Wheeler was 72 years of age. He retired from active work eight years ago.

RICHARD P. HABERSHAM, former engineer of the Spokane, Portland & Seattle R.R., died at Portland, Ore., on Oct. 12, age 74 years. Mr. Habersham went to the Pacific Coast when a young man, and was active in much of the early railroad construction work there.

IRVILLE D. WATERMAN, former assistant chief engineer, New York, New Haven & Hartford Railroad, died at New Haven, Conn., on Oct. 30. Mr. Waterman was a native of South Weymouth, Mass., and a graduate of Massachusetts Institute of Technology.

DANIEL F. CROWLEY, consulting engineer, Bristol, Conn., died suddenly there on Oct. 26. Mr. Crowley suffered a stroke some time ago while engaged on water supply work at Ticonderoga, N. Y.

CONSTRUCTION STATISTICS OF THE WEEK

HIGHWAY lettings, following a lull in the previous week, came back strong last week with $14,816,000 reported in road awards. Federal contracts fell off slightly, but were well above the 12 million dollar mark. The renewed activity in the road field more than doubled the state and municipal awards over the previous week. Private contracts show no evidence of increased activity in private construction. In all, heavy construction is holding close to the two-year high record set in October. Large contracts let last week include the twin locks on the Ohio at Gallipolis, $3,146,000; levees in the Tensas Basin, $1,459,000, and highway work exceeding a million dollars each in Kansas, Texas, Alabama, New York, and Pennsylvania.

CONTRACTS
(Thousands of Dollars)

	Weekly Average Week Nov. 1932	Prev. 4 Weeks	Nov. 2, 1933
Federal Government	$6,269	$15,604	$12,298
State and municipal	15,479	14,066	16,926
Total public	$21,748	$29,670	$29,224
Total private	3,363	5,736	4,908
Week's total	$25,111	$35,406	$34,132
Cumulative to date:			
1932	$1,040,617	1933	$852,492

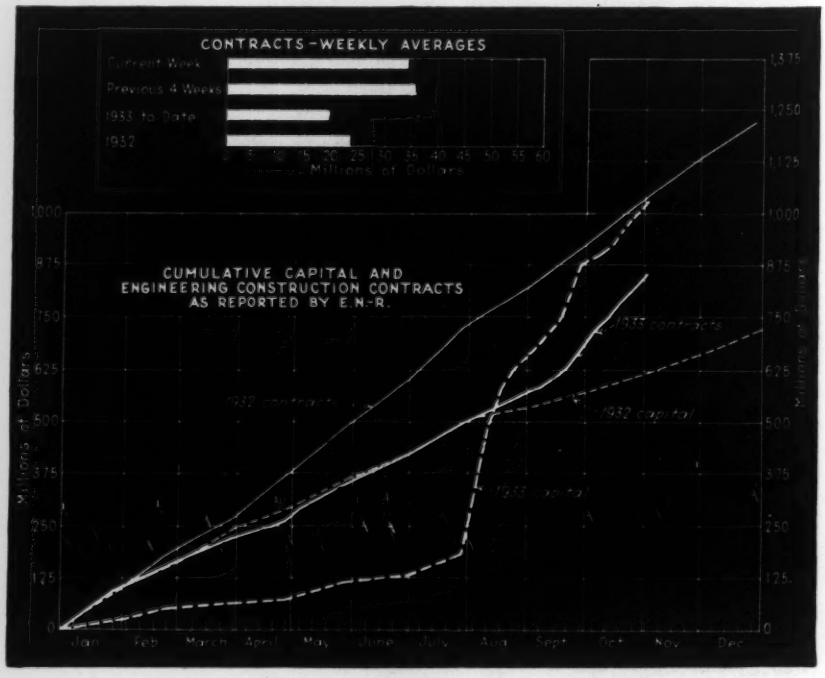
NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

	Week Nov. 2, 1933	Cumulative, 1933
State and municipal	$29,841	$268,762
PWA allotments, public	12,873	666,566
Corporate issues	....	48,547
PWA allotments, private	1,980	48,553
Total new capital	$44,694	$1,032,428
Cumulative, 1932		$623,000

NOTE: These figures include private bonds and stock sold for productive purposes; state and municipal bonds for construction; R.F.C. advances for self-liquidating loans; PWA loans and grants to states and municipalities, including the special highway funds; and PWA private loans.

INDEX NUMBERS

E.N.R.-Cost		E.N.R.-Volume	
November, 1933	**190.14**	**October, 1933**	**162**
October, 1933	187.74	September, 1933	122
November, 1932	158.20	October, 1932	137
1932 (Average)	156.97	1932 (Average)	127
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.35	1930 (Average)	260
1913 (Average)			100

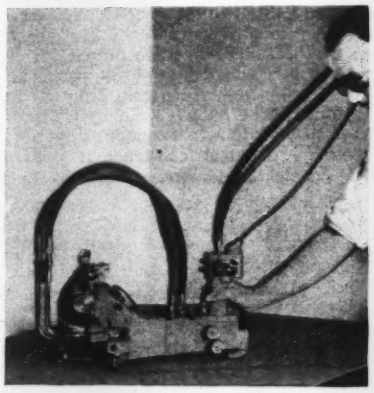


Construction Equipment and Materials

Portable Gas Cutting Machine

A portable gas cutting machine weighing but 43 lb. has been announced by the Linde Air Products Co., 30 East 42d St., New York. The manufacturer states that the new machine combines the portability of a blowpipe with the accuracy and finish of a cutting machine.

Essentially it consists of a blowpipe mounted on an electrically driven, air-cooled, dust-proof chassis, running either



Oxy-acetylene cutting machine

on a 1½-in. angle-iron track, furnished with it, or on any relatively smooth plate. When operated on the track, it does straight-line cutting automatically. For cutting simple shapes it can be guided with a hand-grip, and for automatic circle-cutting, a center and radius rod are furnished. The blowpipe can be adjusted vertically and horizontally and also to cut bevels up to 45 degrees.

Special Plow Digs Trench For Oil or Gas Lines

Designed especially to facilitate the laying of oil and gas lines, the Le Tourneau pipe-line plow has just been announced by R. G. Le Tourneau, Inc., of Stockton, Calif., manufacturers of heavy earth-moving equipment. The plow consists of two plow shares, both throwing furrows to the center, an elevating moldboard, and a side wing or blade for disposing of the earth, the whole mounted on a wheeled frame in such manner that the depth of the furrow taken can be controlled by cable from the power-control unit mounted on the tractor which draws the plow. The new tool will dig a 30-in. trench in three cuts, depositing the earth taken out about 6 ft. to the right of the center line. The position of the sidewing is variable and the wing can be controlled independently of the plow shares. The plow is readily handled by a 75-hp. tractor in high gear.

New pipe-line plow by Le Tourneau

New Equipment in Brief

Wire Rope Socket. The American Steel & Wire Co., 208 So. LaSalle St., Chicago, Ill., announces the Fiege tiger-claw wire rope socket. The socket is composed of three simple parts: a socket, a sleeve and a plug. The plug is used to expand the wire rope within the sleeve, which is then threaded into the socket.

Water Level Recorder. The Service Recorder Company, Cleveland, Ohio, announce their new water level recorder. It is strong, inexpensive, compact, light in weight, about 6 lbs., weather-proof, and quite simple. Being inexpensive and easy to handle, it suggests uses where the usual type of recorder is not indicated.

Screens. Two improved Allis-Chalmers vibrating screens are now available for sizing crushed stone, slag, ore, sand and gravel, and coal and coke, according to an announcement by the Allis-Chalmers Manufacturing Co., Milwaukee, Wis. Style "B" centrifugal screens are built with one, two or three decks in sizes from 2x6 ft. to 5x14 ft. and are adaptable for heavy loads and the maximum range of material size. The "Aero-Vibe" screen, single or double deck, is available from 1½x3 ft. to 4x8 ft. sizes for handling medium to fine size materials and for limited tonnage.

Self-Priming Pump. A new self-priming centrifugal pump is announced by the Gorman-Rupp Co., Mansfield, Ohio. Water from a water chamber traps air on the front face of each impeller vane as it approaches the discharge from the impeller chamber. The water and trapped air are pushed up over the cut-off and into the water chamber. As the tip of the vane passes the cut-off, the water from the chamber drops down onto the intake end of the oncoming impeller vane and likewise traps air there. The oscillating motion of the water continues until sufficient air has been removed from within the pump to draw the water into the suction.

Coupling: The Quick-Hitch Coupling Co., New York City, announce a new hose coupling, the Quick-Hitch Coupling, perfected and patented by the former chief engineer of the Grand Rapids Fire Department. Advantages obtained are that it can be attached by one man with a fraction of a turn, making a watertight connection that will withstand a pressure of 850 pounds, without the use of any tools; that it can be attached to a male thread easily and quickly no matter how badly damaged the thread may be nor at what angle the coupling is applied; that the lugs will not catch on projections as the hose is dragged along. It is said that two lengths of hose may be connected in the dark or under water easily.

New Publications

Water Treatment. D. W. Haering & Co., Inc., 3408 Monroe St., Chicago, Ill., announce publication of a 16-page booklet on water treating. The booklet describes the application of H-O-H treatment to various water problems and explains in detail the cause and effect of many problems common to boiler and hot water equipment.

Metal Cribbing. A new 24-page illustrated catalog describing Armco metal cribbing has recently been published by the Armco Culvert Manufacturers Association, Middletown, Ohio. The booklet is devoted mainly to showing the various places where metal cribbing has been and can be used, as wing walls and abutments on bridges and grade separations, for culvert wing walls or for raising headwalls on large culverts, for widening roads and streets where right-of-way is limited, for track elevation work in cities, for grade separations, where parallel streets, roads, or tracks are close together but at different elevations, for stabilizing slopes, and for many other purposes.

Business Notes

WHITING CORP., Harvey, Ill., announces that E. C. Rice has been appointed manager of the Crane Division.

CHICAGO PNEUMATIC TOOL CO. announces the opening of a new branch office at 1028 Sixth Ave. South, Seattle, Wash., Mr. A. M. Andresen, manager.

HARDINGE CO., INC., York, Pa., and WESTERN PIPE & STEEL CO., have affiliated for the purpose of handling Hardinge Co. business in the West. The name of the new affiliation is Hardinge-Western Co. and its offices are at 444 Market St., San Francisco, Calif.

GRANT B. SHIPLEY has been elected chairman of the board of directors of the Wood-Preserving Corp., subsequent to his resignation as president of the Wood Preserving Corp., Century Wood Preserving Co., National Lumber & Creosoting Co. and Carolina Wood Preserving Co.

DAY PULVERIZER CO., Knoxville, Tenn., manufacturers of pulverizing and crushing machinery, has announced the completion of a sales agreement with the J. D. Adams Co., of Indianapolis, Ind., whereby the J. D. Adams Co. will sell and service the Day traveling-jaw-type rock crusher in a number of states.

THE T. L. SMITH CO., 2835 N. 32d St., Milwaukee, Wis., is now in receivership and will be operated entirely separately from its former affiliated companies, National Equipment Corp., Koehring Co., etc. The receiver, Harold E. Smith, was president of the T. L. Smith Co. from 1916 to 1930, and the organization which will be used by him will be composed as far as possible of men who were associated with him while the company was under his management. The company is now in position to service any of its machines now in the field and to fill orders for repair parts and new machines.

Business Side of Construction

Federal and Highway Contracts Raise October Awards to New High

FEDERAL contract awards, mostly for river and harbor work, and highway lettings accounted for three-fourths of the total of all engineering construction contracts reported in October, and raised the total to $141,622,000 (four weeks), or an average of 35.4 million dollars per week, the highest weekly average in exactly two years. Federal contracts alone averaged $15,200,000 per week, the highest in over two years. Highway lettings reached a 13-months' high average of $10,600,000 per week. Since the early part of August, when the national highway program got under way, road contracts in excess of 100 million dollars have been reported. While public works awards in October showed a gain of 50 per cent over September contracts, private construction fell off to $5,700,000 per week, the lowest in five months. Industrial building, after showing slight signs of revival the past four months, dropped back to the low volume prevailing last spring. Commercial building contracts were at the lowest point of the year. Except for highway and federal work, construction financed by the PWA has not reached the contract stage to any great extent.

In a geographical distribution of contracts, all sections of the country except the Far West registered high weekly averages for the year. In the South and west of the Mississippi areas October contracts were the highest in two years. Levee and dredging work in the lower Mississippi basin and in Florida accounted for much of the South's construction last month.

The steady upward trend of construction costs remains unchecked. Under pressure of increasing lumber and labor costs, the *Engineering News-Record* Cost Index advanced for the fifth consecutive month, reaching 190.14, the highest since April, 1931. Many of the construction commodities reported in the following pages registered increases in price since a month ago. Lumber in particular rose in price in many places; vitrified sewer pipe and building tile prices also stiffened. A notable exception to the general price rise was in the cost of steel rails, which dropped from $40 to $36.375 per ton at the mills on Oct. 30.

Materials notes

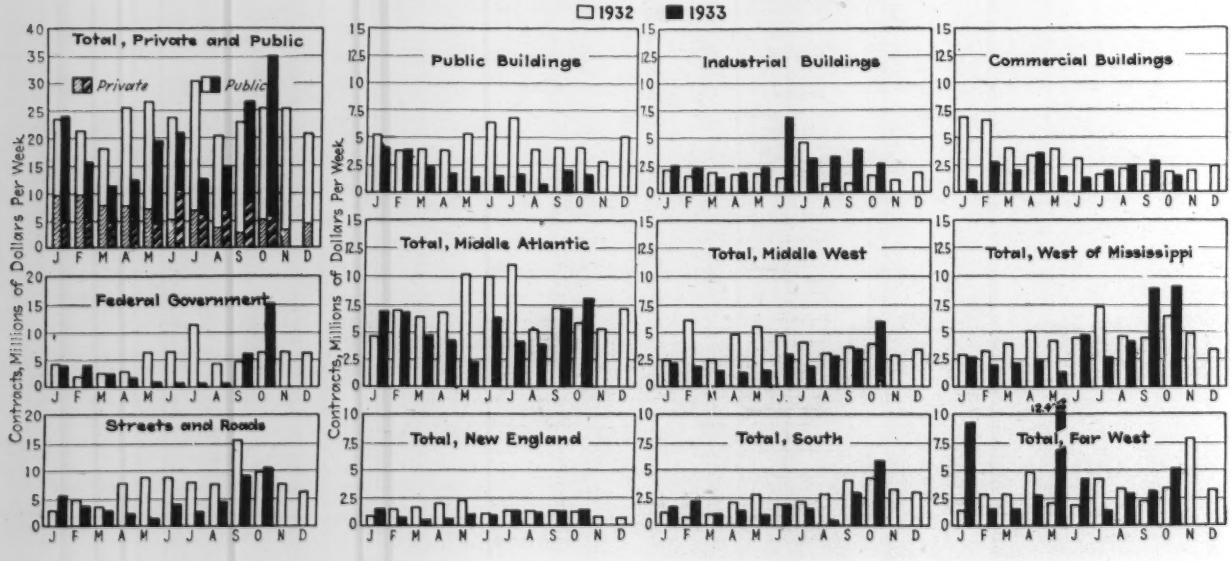
Steel—The production of steel ingots continued to fall off during October, reaching an estimated capacity of 31.8 per cent on Oct. 23. The average output for September is estimated at 40.89 per cent of capacity by the American Iron & Steel Institute. The September output amounted to 2,310,982 tons. Tonnage shipped and bookings of steel construction both fell off during September, according to the

ENGINEERING CONSTRUCTION CONTRACTS REPORTED IN OCTOBER, 1933

Four Weeks—Thousands of Dollars (000 omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States Oct. 1933	United States Ten Months 1933	United States Ten Months 1932	Canada Oct. 1933
Public Works										
Waterworks	31	285	96	173	74	518	1,177	62,877	24,136	138
Sewers	199	74	.....	1,574	267	29	2,143	14,194	20,789	126
Bridges, public	1,016	2,866	222	1,059	2,885	812	8,860	68,319	46,470	.....
Earthwork and waterways	795	5,430	14,008	10,003	14,860	6,150	51,246	99,071	80,676	10
Streets and roads	1,716	8,474	4,422	6,262	12,828	8,808	42,510	196,330	320,065	316
Buildings, public	576	1,980	771	984	1,598	1,045	6,954	87,630	203,111	375
Unclassified, public	65	3,528	435	262	677	822	5,789	17,153	35,750	323
Total public	4,398	22,637	19,954	20,317	33,189	18,184	118,679	545,574	730,997	1,288
Federal gov't. (included in above classification)	1,094	7,873	15,166	10,209	16,752	9,578	60,672	145,305	215,319	.....
Private										
Bridges, private	.....	4,314	.....	.....	80	.....	4,394	12,204	3,908	.....
Buildings, industrial	692	1,833	3,263	2,601	821	1,630	10,840	133,554	78,928	4,345
Buildings, commercial	525	3,271	.....	615	250	131	4,792	84,430	146,647	315
Unclassified, private	305	190	.....	21	2,070	331	2,917	42,598	55,026	584
Total private	1,522	9,608	3,263	3,237	3,221	2,092	22,943	272,786	284,509	5,244
October, 1933 (4 weeks)	**5,920**	**32,245**	**23,217**	**23,554**	**36,410**	**20,276**	**141,622**	.....	.....	**6,532**
September, 1933 (4 weeks)	5,056	28,296	12,061	13,475	34,781	12,368	106,677	.....	.....	1,981
October, 1932 (4 weeks)	5,285	23,319	17,551	15,824	25,334	13,499	100,812	.....	.....	1,139
Ten months, 1933	43,862	231,166	82,861	109,330	169,256	181,885	.....	818,360	.....	26,853
Ten months, 1932	66,439	345,918	99,623	177,075	200,162	127,289	.....	.....	1,015,506	38,713

CONTRACTS REPORTED - WEEKLY AVERAGES - 1932-1933



American Institute of Steel Construction, amounting to 64,362 and 57,642 tons, respectively. August bookings were 78,379 tons, shipments were 67,913 tons. The lowering of steel rail prices is expected to result in large orders in the near future, estimates placing the requirements at close to 1,000,000 tons.

Cement—The Portland cement industry in September, 1933, produced 5,638,000 bbl., shipped 6,517,000 bbl., and had in stock at the end of the month 21,199,000 bbl., according to reports of the Bureau of Mines. Production showed a loss of 31.3 per cent and shipments a decrease of 33 per cent as compared with those of September, 1932. The ratio of production to capacity of the industry is rated at 25.5 per cent for September, as compared with 26.5 per cent for August and 30.6 per cent for September of last year. Production for the first nine months of 1933 totals 50,138,000 bbl., as compared with 57,860,000 bbl. for the same period last year. Shipments for the nine-month period were 49,135,000 bbl. for 1933 and 64,219,000 bbl. for 1932.

Labor and employment

Continued increases in employment are reported from all sources, though definite figures are a month late. The Bureau of Labor Statistics reports an estimated return of over 620,000 workers to employment in September. The National Industrial Conference Board places the increase in employment in September at 2.8 per cent. The Federal Employment Stabilization Board's index of employment in the production of six major construction commodities rose from 45.9 in August to 46.1 in September. New York State reports 507.2 applications for every 100 positions offered in September, as compared with 686.2 in August.

The *ENR* average skilled construction wage rate for Nov. 1 is $1.037, an increase of 0.8c. over the Oct. 1 average rate. The average of common construction wages Nov. 1 is 51.02c., an increase of ½c. during the month of October.

Washington—A temporary truce between carpenters and ironworkers on the I.C.C.-Labor building permitted 1,000 men to return to work after being on strike for a month. The dispute involved setting of metal radiator covers, with jurisdiction claimed by both trades. It is estimated that $8,000 daily was lost in wages over the dispute which involved only $800 worth of work. The administration had warned the striking unions that unless a quick settlement was made permitting the men to return to work, authority would be sought in the next Congress to deal with such cases. The National Labor Board is conducting final settlement of the dispute. Meanwhile the radiator covers are being left out.

Indianapolis—A strike of 600 local carpenters lasting for one month was settled when the men agreed to return to work at a lower scale than prevailed at the start of the strike. A rate of $1 was in effect, based upon an alleged agreement with contractors to raise the rate when the cost of commodities went up. An increase was refused, precipitating the strike. The men finally returned to work at a reported rate of 75c.

Baltimore—The city cannot incorporate in specifications for work financed wholly by the city requirements that a stipulated minimum wage must be paid, according to an opinion by the city solicitor. The opinion was based on failure of the legislature in a recent session to grant the city the necessary power.

Newark, N. J.—Following a ten-day strike precipitated by carpenters, sheet metal workers and ironworkers over jurisdiction in setting metal window frames in the new postoffice, settlement was made by dividing the work among the three trades. Jurisdiction over metal window frames has been the cause of many disputes in Essex County in the past, and never has been definitely allocated.

Texas—A minimum rate of $1.50 for all building trades in the state is asked by the state building trades council. Minimum rates of $1 for skilled and 50c. for unskilled labor on highway work is also urged by the council. A 30-hour week is contemplated.

Atlanta—A jurisdictional dispute between carpenters and metal workers over the installation of spiral mail chutes in the new postoffice delayed the completion of the structure two or three weeks. The dispute was settled temporarily, permitting other work to resume, pending a decision from Washington.

New York—The National Labor Board has voted that the rate of $13.20 for New York bricklayers, existing up to May 1, 1932, when the last agreement expired, should be extended to Feb. 28, 1934. About $100,000 in wages has been held in escrow pending the decision on bricklayers' pay.

Montreal—Fifteen bricklayers threaten to sue the city for wages alleged due because the city, after an aqueduct contract on which the men received $1.20, had been completed, continued work on an extra basis, but lowered the scale to 70c. The men claim the $1.20 rate should have prevailed throughout.

Colorado—The state industrial commission has handed down decisions granting labor increases in pay for state work. For the three cities of Denver, Pueblo and Colorado Springs, the scales are: skilled, $1.25; semi-skilled, 80c.; unskilled, 62½c. For the rest of the state the rates are: $1.10, 75c. and 60c., respectively. All rates are based on a 30-hour week.

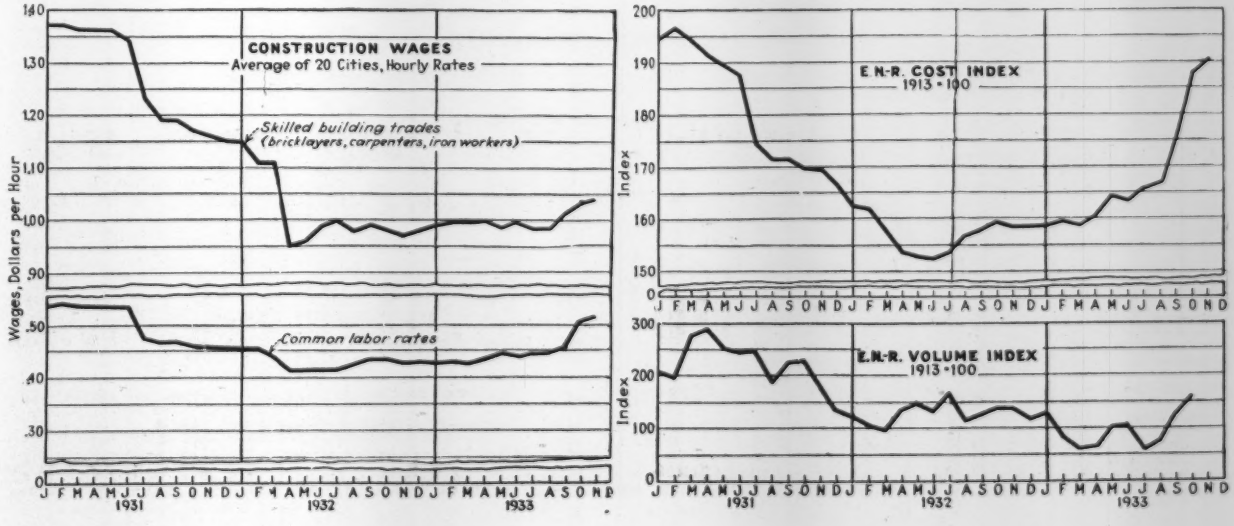
Washington—Although ironworkers have been authorized by the unions to return to an 8-hour day, some contractors are continuing the former practice of split-shifts to spread employment.

E.N.-R. Cost and Volume Index

For the fifth consecutive month, the *ENR* cost index advanced, reaching 190.14 for November, or about the same level as prevailed in April, 1931. Increases in the labor and lumber components raised the index from the October mark of 187.74. The steel and cement components did not change. The *ENR* Volume Index for October rose to 162, the highest since July, 1932, and a gain of 40 points over the September volume figure.

INDEX NUMBERS

E.N.R.-Cost		E.N.R.-Volume	
November, 1933	**190.14**	**October, 1933**	**162**
October, 1933	187.74	September, 1933	122
November, 1932	158.20	October, 1932	137
1932 (Average)	156.97	1932 (Average)	127
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.35	1930 (Average)	260
1913 (Average)	100		



Current Prices of Construction Materials

Cement, Aggregates and Ready-mixed Concrete

	PORTLAND CEMENT — Per bbl., carload lots, f.o.b. city, including cost of bags			SAND AND GRAVEL — Per ton, carload lots, f.o.b. city			CRUSHED STONE — Per ton, carload lots, f.o.b. city		CRUSHED SLAG — Per ton, carload lots, f.o.b. plant		CONCRETE — Ready Mixed 1:2:4, 50c.y. or more, delivered
	Cloth Bags*	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.92	$2.67	$2.67	$1.90	$1.90	$1.45	$1.90	$1.90	$1.90	$1.90	$8.00
Baltimore	2.71	2.46	2.26	1.80‡	2.00‡	1.20‡	1.75‡	1.75‡	2.25	2.25	6.75
Birmingham	2.67	2.42	.....	3.00†‡	3.00‡†	2.40†‡	.....	.....	.80	.80	5.75
Boston	2.72	2.47	2.27	1.50	1.50	1.10	1.50	1.50	.....	.....	6.00
Chicago	2.85‡	2.50‡	2.09	2.50†	2.50†	2.25†	2.50†	2.50†	.....	.....	.....
Cincinnati	2.56	2.31	2.01	1.30	1.30	1.20	1.81	1.81	.....	.....	7.50
Cleveland	2.50	2.25	.....	.....	1.65	1.55	1.55	1.55	1.75	1.75	7.50
Dallas	2.45	2.20	1.95	1.40	1.40	1.65	1.80	1.90	.....	.....	6.50
Denver	2.85	.....	.....	1.85	.....	1.25	.....	.....	.....	.....	.....
Detroit	2.27	2.02	1.82	1.15	1.05	.85	.72	.72	.90	.90	5.75
Kansas City	2.87	2.62	2.20	.65	.65	.50	1.25	1.25	.....	.....	7.50
Los Angeles	.90	2.65	.....	1.90	1.90	1.40	1.90	1.90	.....	.....	6.70
Minneapolis	2.85	.....	2.40	1.00	1.00	.25	1.00	1.00	.....	.....	7.00
Montreal	.....	1.70	.....	.....	1.50	1.35	.....	1.25	.....	.....	.....
New Orleans	.....	.....	2.20	1.60	1.60	1.30	.....	.....	.....	.....	6.05
New York	2.90‡	2.65‡	.....	1.50†	1.50†	1.00†	1.75†	1.75†	.....	.....	7.75
Philadelphia	2.55	2.30	.....	2.00‡	2.25‡	1.80‡	1.75‡	2.00‡	1.75‡	1.75‡	6.84
Pittsburgh	2.50	2.25	1.65	1.50‡	1.50‡	1.70‡	2.25‡	2.25‡	1.25	1.25	8.25
St. Louis	2.49	2.24	.....	1.95‡	1.50‡	1.65‡	1.05‡	1.05‡	.75§	.75§	7.20
San Francisco	2.37	2.17	1.87	1.75	1.75	1.75	1.65	1.65	.....	.....	.....
Seattle	2.75	2.50	.....	1.25†	1.25†	1.25†	.....	.....	.....	.....	5.50

*Includes 40c. per bbl. for bags, 10c. allowed for each returnable bag. †Per cu. yd. ‡Delivered. §F.o.b. Granite City, Ill.

CURRENT MILL PRICES CEMENT TO DEALERS, CARLOAD LOTS, F.O.B. MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Alpena, Mich.	$1.65	$1.60	Iola, Kans.	$1.70	$1.65	Richard City, Tenn.	$1.70	$1.65
Buffington, Ind.	1.60	1.55	La Salle, Ill.	1.60	1.55	Riverside, Calif.	1.72	1.67
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind.	1.60	1.55	Saginaw, Mich.	1.65	1.60
Hannibal, Mo.	1.60	1.55	Mason City, Ia.	1.70	1.65	Steelton, Minn.	1.80	1.75
Hudson, N. Y.	1.75	1.70	Norfolk, Va.	1.76	1.71	Universal, Pa.	1.65	1.60
Independence, Kans.	1.70	1.65	Northampton, Pa.	1.65	1.60	Waco, Tex. (Inc. 5c. Tax)	1.80	1.75
Ironton, Ohio	1.60	1.55	North Birmingham, Ala.	1.75	1.70	Wyandotte, Mich.	1.60	1.55

Structural Clay Building Tile, Brick and Lime

	STRUCTURAL CLAY TILE — PARTITION — Per M, lots of 2,000 pieces or over, delivered			STRUCTURAL CLAY TILE — LOAD BEARING — Per M, lots of 2,000 pieces or over, delivered			BRICK — Per M, in quantity, delivered		LIME — Per ton, in paper, carload lots, delivered		
	3x12x12 in.	4x12x12 in.	8x12x12 in.	8x12x12 in.	10x12x12 in.	12x12x12 in.	Common backing	Straight hard	Hydrated finishing	Common hydrated	Pulverized or lump
Atlanta	$75.00	$95.00	$160.00	$208.40	$243.20	$277.90	$10.00	$10.00	$17.50	$13.00	$13.00
Baltimore	60.00	62.50	125.00	132.00	190.00	225.00	13.00	14.00	16.00	12.00	18.00
Birmingham	.....	89.00	167.00	.....	219.00	250.00	10.00	.....	.....	.....	.....
Boston	77.50	97.50	182.70	194.00	239.00	273.00	13.50	16.50	19.00	15.00	17.65
Chicago	58.50	62.40	85.80	.....	.....	.....	9.20	10.20	18.00	18.00	16.00
Cincinnati	43.25	52.80	97.00	112.20	148.10	168.40	11.00	15.00	14.50	12.40	.....
Cleveland	45.00	48.00	90.00	117.00	136.50	156.00	16.00	16.00	18.00	16.00	16.00
Dallas	82.75	90.00	163.50	196.00	195.75	233.00	.....	15.50	18.50	.....	2.20§
Denver	75.00	80.00	135.00	135.00	185.00	220.00	11.75	25.50	18.00	16.00	2.60§
Detroit	60.00	64.00	120.00	170.00	200.00	250.00	11.50	12.00	20.00	20.00	16.00
Kansas City	62.50	75.00	140.50	.....	150.00	.....	13.00	.....	.60‡	.55‡	.50‡
Los Angeles	77.50	94.25	134.00*	188.00	232.50	311.50	11.50	.....	18.70	.....	19.70
Minneapolis	77.00	84.00	143.00	165.00	173.00	240.00	10.00	18.00	25.50	21.00	21.00
Montreal	.....	110.00	.....	.....	260.00	.....	19.00	32.00	20.00	16.00	16.00
New Orleans	.....	.....	.....	.....	.....	.....	.....	.....	23.00	12.50	1.95§
New York	81.00	86.00	129.00	193.30†	238.80†	295.60†	12.75	.....	19.00	15.00	20.00
Philadelphia	78.00	85.00	160.00	195.00	235.00	295.00	15.00	18.00	14.60	11.00	10.50
Pittsburgh	52.00	55.60	104.20	118.00	155.00	192.00	15.00	20.00	16.50	15.50	17.40
St. Louis	57.00	60.00	110.00	130.00	150.00	190.00	12.00	14.00	.55‡	.40‡	2.25§
San Francisco	68.00	76.50	174.00	.....	.....	.....	14.00	16.00	22.50	19.00	.....
Seattle	80.00	87.00	200.00	50.00	.....	.....	14.00	16.00	24.00	24.00	2.80§

*6x12x12 in. †F.o.b. Perth Amboy, N. J. ‡Per sack. §Per bbl.

Road Surfacing Materials

	PAVING BRICK AND BLOCKS — Granite Blocks per M. lots of 50,000, 4x8x4 in., f.o.b. city	Brick per M. 3x8½x4 in., carload lots f.o.b. city	Wood Blocks per sq.yd., 3½ in., 16-lb. treat, f.o.b. city	PAVING ASPHALT — Per ton, less than 80 penetration, f.o.b. city Tank car	Drums	ASPHALT BINDERS — FLUXES — Per gal., 80-300 penetration, f.o.b. city Tank car	Drums	CUTBACK ASPHALT — Per ton, f.o.b. city Tank car	Drums	ROAD OILS — Per gal., f.o.b. city Tank car	ASPHALT EMULSION — Per gal., f.o.b. city Tank car	Drums
Atlanta	$3.00*	$35.00	$2.25	$17.20	$21.20	$0.068	$0.10	$19.20	$27.22	$0.068	$0.105	$0.105
Baltimore	130.00	43.00	2.00	15.00	19.00	.06	.08	.07†	.10†	.055	.....	.....
Birmingham	65.00	25.00	.....	11.00	.....	.....	.....	.....	.....	.....	.06	.....
Boston	65.00	32.00	2.00	14.00	18.00	.055	.09	.07†	.105†	.055	.09	.145
Chicago	3.80*	36.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cincinnati	110.00	37.00	.....	15.00	20.00	.....	.....	15.00	.....	.075	.08	.....
Cleveland	125.00‡	37.50	.....	16.00	18.50	.085	.125	18.50	20.00	.048	.065	.10
Dallas	.....	.....	.....	11.85	16.85	.0948	.1448	15.00	21.00	.02	.08	.11
Detroit	.....	34.50	.....	14.29	16.88	.....	.....	13.94	17.94	.....	.....	.....
Kansas City	.....	33.00	2.75	12.00	17.00	.05	.09	.07	.11	.04	.05	.09
Los Angeles	.....	48.50	.....	12.00	16.00	12.00#	16.00#	14.00	.....	.042	.0525	.1125
Minneapolis	.....	.....	2.50	17.30	21.30	.065	.105	19.60	32.20	.048	.....	.....
Montreal	.....	100.00	.....	13.00	18.66	.....	.....	.....	.....	.....	.....	.....
New Orleans	200.00	.....	.....	13.00	18.00	.....	.....	.....	.....	.....	.....	.....
New York	135.00	47.50	2.05	15.00	19.00	.06	.08	.07†	.10†	.055	.08	.11
Philadelphia	.....	45.00	2.02	11.00	17.00	.....	.....	.....	.....	.....	.....	.....
Pittsburgh	115.00	35.00	.....	17.00	21.00	.0675	.0875	.076†	.106†	.0575	.....	.....
St. Louis	2.80*	35.00	2.00	17.50	21.50	.0675	.....	.....	.....	.035	.095	.....
San Francisco	.....	45.00	.....	12.00	18.00	12.00#	18.00§	14.00#	21.50#	.04	.08	.12
Seattle	.....	47.50	.....	18.00	23.10	18.00	23.10	15.00	.....	.02	19.20#	34.20#

*Per sq.yd. Note: Paving asphalt, tank car or boat, f.o.b. Maurer, N. J., per ton, Bermudes, $26.00; Trinidad, $22.00. †Per gallon. ‡4½x6x5½ in. #Per ton.

Current Prices of Construction Materials

Iron and Steel Products—Base Mill Prices

	STRUCT. SHAPES-PLATE Per 100 lb., carload lots	REINF. BARS Per 100 lb., ¾-in. billet, carload lots	RIVETS Per 100 lb., ¾-in. structural carload lots	WIRE NAILS Per 100 lb., base, carload lots	SHEET PILING Per 100 lb., base, carload lots	STEEL RAILS Per Gross Ton: Standard	Light	Re-rolled	TRACK SUPPLIES Per 100 lb., carload lots: Angle bars	Std. spikes	Tie plates	Track bolts
Birmingham	$1.85	$2.00	.....	$2.10	.....	$36.375	$32.00	$31.00	$2.55	$2.40	$1.90	$3.50
Chicago	1.75	1.95	$2.60	2.10	$2.00	36.375	32.00	31.00	2.55	2.40	1.90	3.50
Pittsburgh	1.70	1.90	2.50	2.10	2.00	36.375	32.00	.....	2.55	2.40	1.90	3.50

Iron and Steel Products—Local Prices f.o.b. Warehouse

	STRUCTURAL SHAPES Per 100 lb., base price	REINFORCING BARS Per 100 lb., ¾ in., base price: New billet	Rail steel	EXPANDED METAL LATH Per 100 sq.yd., carload lots: Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING Per 100 s.f., carload lots: 4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6x6 in., No. 6 & 6 wires Per sq.yd.	SHEET PILING Per 100 lb. base price
Atlanta	$3.34	$2.17	$2.02	$19.50	$22.00	$1.60	$1.21	$0.151	$2.45
Baltimore	2.50	2.50	2.25	18.00	20.00	1.46	1.12	.137	2.25
Boston	3.42	2.82	2.32	19.50	23.50	1.50	1.14	.142	2.40
Chicago	2.50	2.43	.....	.....	.....	1.46	1.12	.137	2.00
Cincinnati	2.75	2.50	2.50	19.00	22.00	1.44	1.11	.135	.....
Cleveland	2.90	2.90	2.45	15.40	17.40	1.44	1.11	.135	.....
Dallas	4.00	3.50	3.45	21.00	22.00	1.79	1.27	.161	.....
Denver	3.29	3.54	.....	23.00	27.00	1.79	1.27	.161	.....
Detroit	3.30	2.985	2.85	15.00	19.00	1.48	1.13	.139	2.885
Kansas City	3.10	2.80	2.55	24.50	.....	1.54	1.17	.145	.....
Los Angeles	3.00	2.85	.....	25.00	30.00	2.00	1.40	.18	2.50
Minneapolis	3.35†	2.67†	2.52†	17.00†	20.00†	1.66	1.20	.149	2.40†
Montreal	3.25	3.00	.....	.....	.....	.....	.....	.....	.....
New Orleans	3.50	3.00	.....	.....	.....	1.58	1.20	.149	.....
New York	3.27	2.57	2.42	20.00	23.00	1.53	1.18	.139	.....
Philadelphia	2.60	3.00	.....	18.50	22.00	1.44	1.11	.135	2.28
Pittsburgh	1.70‡	1.80‡	1.75‡	17.00‡	22.00‡	1.44	1.11	.135	2.00‡
San Francisco	3.55	3.15	.....	21.50	24.50	1.90	1.40	.18	.....
Seattle	3.40	3.50	.....	.....	.....	1.90	1.40	.18	.....
St. Louis	2.84	3.29	3.29	20.50	23.50	1.46	1.12	.137	.....

†F.O.B. City. ‡Base Mill Price. Note: Shapes, bars and piling subject to quantity discounts.

Paints and Roofing Supplies

	WHITE LEAD Per 100 lb. keg in oil, f.o.b.	READY-MIXED PAINT Per gal., drums, f.o.b.: Graphite*	Aluminum†	Ferric Oxide‡	ROOFING SUPPLIES Carload lots, f.o.b. city: Rolls, slate surfaced, 85-90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating, per gal.	Tar pitch, 350-lb. bbl., per ton
Atlanta	$11.75	$1.50	$1.50	$1.50	$1.94	$3.02	$3.30	$0.37	$22.80
Baltimore	11.00	1.20	2.00	1.75	1.76	2.50	2.50	.40	25.00
Boston	11.00	1.05	1.80	1.50	1.85	2.50	2.50	.6625	23.00
Chicago	11.00	1.85	2.25	1.25	1.60	1.50*	1.50*	.24	20.00
Cincinnati	11.00	1.40	3.00	1.55	2.40	2.25*	2.25*	.36	25.00
Cleveland	11.00	1.65	2.35	.....	1.65	47.50°	47.50°	.33	19.50
Dallas	12.00	1.30	2.75	.....	1.98	.....	.....	.51	25.00
Denver	11.12½	.....	2.55	.....	2.65	3.35	3.35	.60	30.00
Detroit	11.00	1.55	2.40	1.30	1.59	2.31	2.50	.40	27.00
Kansas City	11.12½	.....	.....	.....	2.10	1.65	.....	.33	.....
Los Angeles	10.75	1.60	2.25	2.30	2.00	1.50	.....	.45	.....
Minneapolis	11.12½	.....	.....	.....	1.60	2.30	2.30	.2925	23.30
Montreal	9.75	.....	.....	.....	.....	2.62	2.02	1.40§	1.63§
New York	11.00	1.58	1.95	1.35	.....	.....	.....	.....	.....
Philadelphia	11.00	.....	.....	.....	.....	.....	.....	.....	.....
Pittsburgh	11.00	1.00	1.85	.75	1.80	1.65*	1.65*	.28	23.00
St. Louis	11.00	1.85	2.25	1.25	1.78	2.60	2.20	.265	26.00
San Francisco	10.75	.....	.....	.....	.....	.....	.....	.....	.....
Seattle	10.75	.....	1.41	.....	3.10	4.50	.....	.54	27.60

*New Jersey State Hwy. Spec. 120M. †ASTM Spec. D266-31. ‡80% maximum ferric oxide. °Per ton. §Per 100 lb. *Per roll.
Note: Red lead dry, same as white lead in oil, red lead in oil 50c higher.

Miscellaneous Items

WINDOW GLASS

Discounts from latest jobbers list, Sept. 15, 1928, for sizes above first three brackets. Single or Double Thickness.

	A quality	B quality
Atlanta	85%	85%
Baltimore	88%	90%
Birmingham	89%	91%
Boston	88%	90%
Chicago	87%	89%
Cincinnati	.....	.....
Cleveland	75%	80%
Dallas	.....	.....
Denver	84@ 5%	86@ 5%
Detroit	87@10%	89@10%
Kansas City	89@10%	89@10%
Los Angeles	90%*	90@40%*
Minneapolis	84%	86%
Montreal	.....	.....
New Orleans	87@10%	90@10%
New York	87%	89%
Philadelphia	88%	90%
Pittsburgh	87%	89%
St. Louis	87%	89%
San Francisco	.....	.....
Seattle	90@10%	90@20%

*Disc. from list Aug. 1, 1929. †F.o.b. Arsenal.

EXPLOSIVES

Per lb dynamite delivered 50-lb. cases. Gelatin.

	40%	60%
Atlanta	$0.215	$0.2375
Baltimore	.18	.195
Birmingham	.15	.1725
Boston	.2225	.2375
Chicago	.17	.195
Cincinnati	.22	.245
Cleveland	.1825	.1975
Dallas	.24	.28
Denver	.19	.205
Detroit	.237	.255
Kansas City	.16	.18
Los Angeles	.1725†	.1925†
Minneapolis	.1725	.1875
Montreal	.1675	.1925
New Orleans	.19	.22
New York	.23	.245
Philadelphia	.215	.24
Pittsburgh	.1175	.1325
St. Louis	.1375	.1525
San Francisco	.1575	.1725
Seattle	.1525	.1675

CHEMICALS

Water, sewage treatment, road work, f.o.b., carlots, New York:	
Bleaching powder, in drums, f.o.b. works, per 100 lb	$1.75@2.00
Calcium chloride, 77-80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, f.o.b. works, freight equalized with points of competition, per ton	19.50
Chlorine, cylinders, per lb. delivered	.05½
Silicate of soda, 60 deg., in drums, f.o.b. works, per 100 lb	1.65
Soda ash, 58%, in bags, per 100 lb	1.17½
Sulphate of aluminum, in 100 lb. bags	1.25@1.40
Sulphate of copper, in bbl., per 100 lb	3.75

PILES

Prices of Nichols Bros., 90 West St., N. Y. C., per linear foot, pine, with bark on, f.o.b., New York; delivered from barge, 1½ to 2c, per ft. additional:

Dimensions	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.09	$0.145
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.13	.195
12 in.—2 ft from butt	6 in.	60 to 69 ft.	.15	.215
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.185	.225
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.2025	.225
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.265	.375
14 in.—2 ft. from butt	5 in.	85 to 89 ft.	.305	.442

RAILWAY TIES

Prices f.o.b., per tie, for carload lots:		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Boston	Oak, untreated	$0.90	$1.20
	Pine, untreated	.90	1.20
	Pine, creosoted	1.35	1.85
New York	Long-leaf sap pine, untreated	.80	1.00
	Mixed oak, untreated	.....	1.00
	White oak, untreated	.75	1.50
Birmingham	White oak, creosoted	1.40	1.45
	Southern pine, untreated	.35	.60
	Southern pine, creosoted	.95	1.35
Chicago	White oak, untreated	1.15	1.35
	Oak, empty cell, creosoted	1.50	1.80
	Oak, zinc treated	1.40	1.65
	Southern pine, creosoted	1.35	1.50
Los Angeles	Fir, untreated	.70	.95
	Fir, creosoted	1.90	2.70
Philadelphia	Red oak, untreated	.95	1.15
	Red oak, creosoted	1.47	1.90
	White oak, untreated	1.00	1.45
St. Louis	Red oak, untreated	.90	1.35
	Red oak, creosoted	1.30	1.85
	Sap Pine or cypress, untreated	.80	1.15
San Francisco	Douglas fir, green, untreated	.45	.63
	Douglas fir, empty cell, creosoted	1.14	1.56
Montreal	Birch or maple, untreated	1.00	1.00
	Birch or maple, creosoted	1.25	1.55

Current Prices of Construction Materials

Water, Sewer and Drain Pipe

	C. I. PIPE Per net ton, f.o.b. 6 in. and over b. & s. class B and heavier, C/L lots*	VITRIFIED SEWER PIPE Per foot, delivered, standard 8 in., s.s.	12 in., s.s.	24 in., d.s.	36 in., d.s.	CLAY DRAIN TILE Per 1,000 ft., carload lots, f.o.b. 6 in.	8 in.	CONC. SEWER PIPE Per ft., delivered; ASTM Spec. C 14-24 12 in.	24 in.	WROUGHT STEEL PIPE Full std. weight. Discounts from standard list for delivery from warehouse, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ¼ in., 9c; ⅜ in., 12c.; ½ in., 17½c.; 2 in., 37½c.; 2½ in., 59c.; 3 in., 77c.; 4 in., $1.10; 6 in., $1.94. 1 to 3 in., Butt Weld Black	Galv.	2½ to 6 in., Lap Weld Black	Galv.
Atlanta	$36.00	$0.225	$0.405	$1.4625	$3.25	$80.00	$128.00	$0.625	$1.625	52%	44.5%	50%	42%
Baltimore	38.50	.26	.50	2.20	4.50	85.00	150.00	.50	1.50	.....	.....	.....	.....
Birmingham	32.00	.30	.54	1.95	5.00	.....	.....	.....	.....	.....	.....	.....	.....
Boston	40.50	.28	.54	2.80	7.175	60.10	101.00	.432	1.935	55.59%	44.83%	56.85%	46.10%
Chicago	40.00	.35	.675	2.25	5.125	120.00	.....	.675	2.25	.....	.....	.....	.....
Cincinnati	39.00	.224	.432	1.71	5.2275	90.00	.....	.38	1.30	57.33%	46.31%	58.55%	47.53%
Cleveland	40.50	.329	.6345	2.61	7.175	42.50	88.50	.536	2.102	53.3%	42.3%	50.8%	37.8%
Dallas	44.00	.30	.54	2.15	.....	99.00	.....	.....	.....	.....	.....	.....	.....
Denver	52.00	.23‡	.415‡	1.73‡	.....	100.50‡	.....	.....	.....	.....	.....	.....	.....
Detroit	40.50	.28	.54	2.25	.....	100.00	150.00	.....	.....	.....	.....	.....	.....
Kansas City	42.00	.335	.52	1.90	3.80	120.00	180.00	.....	.....	.....	.....	.....	.....
Los Angeles	40.50	.2825‡	.508‡	2.03‡	5.535‡	115.50	192.50	1.00	2.00	.....	.....	.....	.....
Minneapolis	42.50	.215‡	.387‡	1.548‡	4.35‡	64.90	120.00	.....	.....	53%	42%	54%	43%
Montreal	.....	.....	1.02	3.64	.....	.....	.....	.....	.....	.....	.....	.....	.....
New Orleans	38.00	.....	.50	1.90	.....	45.00	.....	.....	.....	.....	.....	.....	.....
New York	38.00	.35	.675	2.83	6.56	.....	.....	.50	2.00	56.164%	45.144%	57.389%†	46.368%†
Philadelphia	36.50	.126	.243	1.17	4.615	.....	.....	.....	.....	57.28%	44.68%	53.28%	41.80%
Pittsburgh	41.00	.175‡	.3375‡	1.53‡	4.8175‡	47.00	83.00	.75	1.75	67.5%	58.5%	68.5%‡	59.5%†
St. Louis	39.00	.26	.468	2.85	3.96	85.00	195.00	.....	.....	55.796%	44.76%	57.021%	46.0%
San Francisco	40.00	.25	.45	1.80	4.50	112.00	.....	.....	.....	.....	.....	.....	.....
Seattle	41.50	.35	.63	2.52	.....	84.00	175.00	.50	1.60	60.3%	51.3%	63.3%	52.3%
Burlington, N. J. (base)	35.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

*Gas pipe and class A, $3 per ton additional, 4-in., $3 per ton additional. †3½ to 6 in. ‡f.o.b.

Lumber and Timber

		SHORT LEAF YELLOW PINE AND DOUGLAS FIR Per M ft. b.m., carload lots f.o.b. All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. All Fir planks No. 2 common; Fir timber is No. 1 common. S. L. Y. P. lumber is 10 to 20 ft. Fir lumber is up to 20 ft. 1x6, S4S	1x8, S4S	2x4, S4S	2x6, S4S	2x8, S4S	2x10 S4S	3x12 Rgh	6x12 Rgh.	12x12, Rgh.	LONG LEAF Y. P. Per M ft. b.m., carload lots, f.o.b., merchantable grade up to 20 ft. 2x12, Rgh.	12x12, Rgh.
Atlanta	Southern Pine	$20.00	$20.00	$17.50	$17.50	$17.50	$22.50	$27.50	.....	.....	$45.00	$50.00
Baltimore	Southern Pine	26.00	26.50	24.50	24.50	26.00	29.00	31.00			60.00	58.00
	Douglas Fir	25.50	27.00	26.50	26.50	27.00	27.00	33.50	$31.50	$30.50	.....	.....
Birmingham	Southern Pine	40.00	40.00	.....	.....	.....	.....	50.00	.....	55.00	.....	.....
Boston	Southern Pine	30.00	31.00	38.00†	38.00†	60.00‡	65.00‡	70.00‡	.....	.....	70.00	70.00
	Douglas Fir	31.00	31.00	35.00	35.00	37.00	39.00	42.00	42.00	42.00	.....	.....
Chicago	Southern Pine	32.00	33.00	31.00	30.00	31.00	32.00	47.00	63.00	63.00	52.00	52.00
Cincinnati	Southern Pine	37.00	37.00	30.00	30.00	30.00	33.00	40.00	.....	.....	.....	.....
	Douglas Fir	.....	.....	.....	.....	.....	.....	47.50	47.50	50.00	.....	.....
Cleveland	Southern Pine	39.00	44.00	44.00	41.00	41.00	46.00	52.00	.....	.....	45.00	45.00
	Douglas Fir	39.00	44.00	44.00	41.00	41.00	46.00	60.00	60.00	60.00	.....	.....
Dallas	Southern Pine	28.00	29.00	33.50	31.00	33.50	32.75	47.50	.....	.....	52.50	60.00
	Douglas Fir	32.50	30.00	36.50	34.00	36.50	41.50	52.50	55.00	55.00	.....	.....
Denver	Douglas Fir	38.00	40.00	40.00	40.00	40.00	41.00	51.00	58.00	.....	.....	.....
Detroit	Southern Pine	30.00	32.00	31.00	31.00	30.00	30.00	40.00	.....	.....	39.00	49.00
	Douglas Fir	.....	.....	.....	.....	.....	.....	44.00	49.00	47.00	.....	.....
Los Angeles	Douglas Fir	29.00	29.00	29.00	29.00	29.00	32.00	28.00	32.00	29.00	.....	.....
Minneapolis	Western Pine	42.00	42.00	36.00	36.00	36.00	34.00	42.50	.....	.....	.....	.....
	Douglas Fir	29.50	29.50	29.50	29.50	29.50	34.00	39.50	39.50	42.50	44.50	42.50
Montreal	Spruce	27.00	29.00	21.00	23.00	24.50	31.50	34.50	.....	.....	.....	.....
	Douglas Fir	48.00	51.00	45.00	50.00	53.00	62.00	.....	.....	.....	.....	.....
New Orleans	Southern Pine	18.00	19.00	.....	.....	.....	.....	30.00	.....	.....	.....	.....
	Douglas Fir	21.00	21.00	.....	.....	.....	.....	42.50	.....	.....	.....	.....
New York	Southern Pine	33.00	34.00	35.00	35.00	35.00	37.00	36.00	.....	.....	75.00	75.00
	Douglas Fir	.....	.....	38.00	36.00	37.00	37.00	36.00	40.00	40.00	.....	.....
Philadelphia	Southern Pine	29.00	30.00	28.50	28.00	29.00	31.00	34.00	.....	.....	64.00	64.00
	Douglas Fir	.....	.....	34.50	34.50	35.00	35.00	37.50	40.00	40.00	.....	.....
Pittsburgh	Southern Pine	25.50	26.50	26.50	26.50	27.00	28.00	39.50	.....	.....	55.50	55.50
	Douglas Fir	32.50	32.50	36.50	36.00	36.00	38.00	45.00	45.00	45.00	.....	.....
St. Louis	Southern Pine	33.00*	36.00*	33.00*	31.00*	32.50*	41.00*	49.00*			55.00*	59.00*
	Douglas Fir	.....	.....	.....	.....	.....	.....	55.00*	55.00*	55.00*	.....	.....
San Francisco	Douglas Fir	28.00	28.00	28.00	28.00	28.00	29.00	30.00	31.00	31.00	.....	.....
Seattle	Douglas Fir	21.00	20.00	20.00	19.50	20.50	21.00	18.50	18.50	20.50	.....	.....

*Delivered. †Spruce. ‡Long-leafed Y. P.

Current Building and Construction Wage Rates Per Hour

	Bricklayers	Carpenters	Structural Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const.
Atlanta	$0.75/1.125	$0.40/.90	$0.60/1.25	$0.60/1.25	$0.50/.75	$0.30	$0.30
Baltimore	1.00	.70	1.00	1.00	1.25	.30	.30
Birmingham	.75/.87½	.60	.75	.75	.....	.25/.30	.25/.30
Boston	.90/1.30	.70/1.17½	1.20	.90/1.17½	.90/1.62½	.40/.70	.40/.70
Cincinnati	1.27½	1.02½	1.20	1.07½	1.27½	.45	.40
Chicago	1.50	1.31¼	1.35	1.31¼	1.37½	.82½	.82½
Cleveland	1.25	1.12½	1.25	1.125	1.25	.72	.72
Dallas	1.12½	.875	1.00	1.00	1.125	.40	.40
Denver	.60/1.12½	.60/.87½	.60/.87½	.60/.87½	.....	.50	.50
Detroit	1.00	.50/70	1.00	.70/90	.60/1.25	.35/.50	.35/.50
Kansas City	1.32½	1.12½	1.12½	1.12½	1.32½	.70	.40/.60
Los Angeles	.90	.75	1.12½	.75	.90	.45	.60
Minneapolis	1.25	.75	.90	.75	.90	.40	.50
New Orleans	1.00	.75	1.00	1.00	1.25	30./.40	.30/.40
New York	1.50/1.65	1.25/1.40	1.65	1.50/1.65	1.50	.93½	.62½/.82½
Philadelphia	.75/1.00	.50/.75	.75/1.00	.75/1.00	.....	.35	.30
Pittsburgh	.50/1.50	.50/1.25	.50/1.37½	.50/1.37½	.50/1.25	.35/.70	.35/.70
St. Louis	1.50	1.25	1.47	1.35/1.47	1.50	.78½	.35/.78½
San Francisco	1.12½	.90	1.20	1.00	1.10	.60	.60
Seattle	1.20	.90	1.10	1.00	1.20	.60	.60
Montreal	1.20	.55	.85	.85	.85	.30	.20

Skilled Ave: (Bricklayers, Carp., Ironworkers) $1.037. Common Ave. $0.5102